SOIL SURVEY OF

Douglas and Sarpy Counties, Nebraska

United States Department of Agriculture
Soil Conservation Service
in cooperation with
University of Nebraska
Conservation and Survey Division

Major fieldwork for this soil survey was done in the period 1963-69. Soil names and descriptions were approved in 1969. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1970. This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska Conservation and Survey Division. It is part of the technical assistance furnished to the Papio Natural Resource District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Douglas and Sarpy Counties are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the windbreak suitability group and range site to which the soil has been assigned.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the descriptions of the capability units, the range sites, and the windbreak suitability groups.

Foresters and others can refer to the section "Woodland and Windbreaks," where the soils of the county are grouped according to suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife and Recreation."

Ranchers and others can find, under "Management of Range," groupings of the soils according to their suitability for range and the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about soil formation and classification in the section "Formation and Classification of the Soils."

Newcomers to Douglas and Sarpy Counties may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "Environmental Factors Affecting Soil Use."

Cover: **Terraces, waterways, and windbreaks on Marshall, Ponca, and Kennebec soils.**

Contents

Issued December 1975

SOIL SURVEY OF DOUGLAS AND SARPY COUNTIES, NEBRASKA

BY PAUL A. BARTLETT, SOIL CONSERVATION SERVICE

SOILS SURVEYED IN DOUGLAS COUNTY BY PAUL A. BARTLETT, AND IN SARPY COUNTY BY PAUL A. BARTLETT, KENNETH GOOD, AND HOWARD SAUTTER, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH UNIVERSITY OF NEBRASKA CONSERVATION AND SURVEY DIVISION

DOUGLAS AND SARPY COUNTIES[1] are in the east-central part of Nebraska (fig. 1). Douglas County is bordered on the east by Iowa, across the Missouri River, and on the south by Sarpy County. Douglas County has a total land area of 214,208 acres. Sarpy County has a total land area of 152,704 acres. Omaha, the largest city in Nebraska, is the county seat of Douglas County; Papillion is the county seat of Sarpy County.

The first permanent settlement in Douglas County was made in 1854, and the county was established in the same year. The first permanent settlement in the area that is now Sarpy County was made in 1810, when a fur company established a trading post at the present site of Bellevue. In 1857 the southern part of Douglas County was used to form Sarpy County, which was named after Peter A. Sarpy, an agent for the fur company.

Commerce and industry are important occupations in the east-central part of Douglas County and are increasingly important in the northeastern part of Sarpy County. Farming is still the leading occupation in the western half of Douglas County and in the western three-fourths of Sarpy County. Corn, soybeans, alfalfa, small grain, and grain sorghum are grown extensively on farms. The crops provide feed for cattle and hogs as well as for cash income.

Although the importance of farming has diminished in Douglas County and is becoming less important in Sarpy County, farm products are still highly important to the economy of the city of Omaha and the surrounding areas. The processing and shipping of grain, grain products, and livestock provide employment for thousands of persons in this area. Approximately 646,000 tons of products of various kinds are moved each year by barges on the Missouri River.

These counties are in the Great Plains region of the United States. Within this region, the western parts of the counties are in the Loess, Till, and Sandy Prairies Resource Area, and the eastern parts of both counties are a part of the Iowa and Missouri Deep Loess Hills Resource Area.

[1] Former surveys of the two counties are available. This survey provides up-dated information on technical advances, engineering techniques, and soil classification. For additional information see Soil Survey of Douglas County, 1913, and Soil Survey of Sarpy County, 1939.

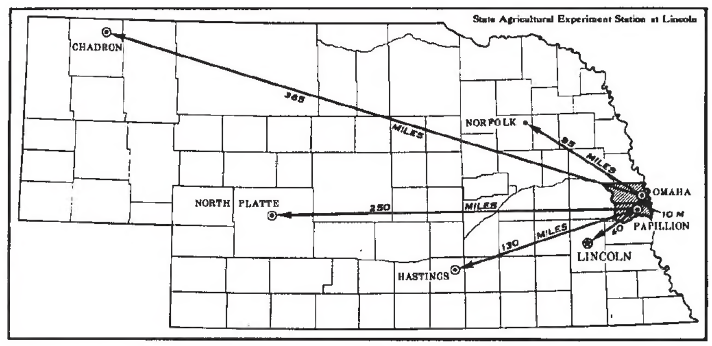


Figure 1.—Location of Douglas and Sarpy Counties in Nebraska.

Most soils on uplands are deep, well drained, and have a medium to moderately fine texture. The soils on bottom land vary widely in drainage and texture.

As the city of Omaha continues to expand, it is expected that more of the survey area will become urbanized.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Douglas and Sarpy Counties, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and nature of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Marshall and Monona, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Marshall silty clay loam, 0 to 1 percent slopes, is one of several phases within the Marshall series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this survey was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent because it is not practical to show on such a map all the small, scattered bits of soil of some kind that are within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Douglas and Sarpy Counties: soil complexes and undifferentiated soil groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex generally consists of the names of the dominant soils, joined by a hyphen. Marshall-Ponca silty clay loams, 7 to 11 percent slopes, eroded, is an example.

An undifferentiated soil group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of the group generally consists of the names of the dominant soils, joined by "and." Monona and Ida silt loams, 11 to 17 percent slopes, eroded, is an undifferentiated soil group in Douglas and Sarpy Counties.

In most areas surveyed are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Cut and fill land is a land type in this survey.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all arable soils.

Soil scientists observe how soils behave when used for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to slow permeability or a high water table. They see that streets, road pavements, and foundations for houses cracked on a given kind of soil, and they relate this failure to a high shrink-swell potential. Thus, they use observation and knowledge of soil properties, together with available research data, to predict the limitations or suitability of a soil for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their study and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Douglas and Sarpy Counties. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The terms for texture used in the title of the associations apply to the texture of the surface layer. For example, in the title of the Albaton-Haynie association, the words, silty and clayey, refer to the texture of the surface layer.

Soil association names and delineations on the general soil map do not fully agree with those of the general soil maps of adjacent counties published at a different date. Differences on the maps are the result of improvements in the classification or refinements in soil series concepts. In addition, more precise maps are needed because the uses

of the general soil map have expanded in recent years. The more modern maps meet this need.

The six soil associations in Douglas and Sarpy Counties are described on the following pages.

1. Cass-Inavale-Wann association

Deep, somewhat excessively drained to somewhat poorly drained, nearly level loamy and sandy soils on bottom land along the Platte and Elkhorn Rivers

This association (fig. 2) is in narrow strips along the Platte and Elkhorn Rivers. The soils formed in moderately coarse and coarse textured sediments deposited by water. Many areas are dissected by shallow swales and channels.

This association makes up about 4 percent of the survey area. It is about 35 percent Cass soils, 34 percent Inavale soils, 28 percent Wann soils, and 3 percent less extensive soils.

Cass soils are on the higher part of the landscape. They are deep, nearly level, and well drained. Their surface layer is very dark brown and black fine sandy loam and very fine sandy loam. The transitional layer also is very dark brown fine sandy loam. The underlying material at a depth of 20 inches is dark grayish-brown fine sandy loam. It is medium and coarse sand in the lower part.

The nearly level and low hummocky Inavale soils are slightly higher in elevation than the surrounding soils. They are deep and somewhat excessively drained. Their surface layer is dark grayish-brown loamy fine sand. The transitional layer is brown loamy fine sand. The underlying material at a depth of 11 inches is light brownish-gray loamy fine sand that becomes coarser with increasing depth.

Wann soils are on the lowest part of the landscape. They are deep, nearly level, and somewhat poorly drained. Their surface layer is black fine sandy loam. The transitional layer is very dark gray to gray fine sandy loam. The underlying material at a depth of 23 inches is grayish-brown fine sandy loam.

Less extensive in this association are Platte soils, Sandy alluvial land, Pits and dumps, and Riverwash. The shallow Platte soils are in old abandoned river channels and other low-lying areas. Sandy alluvial land is adjacent to the rivers and is subject to occasional flooding. Active and old gravel pits within the counties are mapped as Pits and dumps. Sand bars within present or abandoned river channels are mapped as Riverwash.

Farms are diversified, mainly a combination cash-grain and livestock type. Few farms are entirely on this association. Nearly every farm bordering the Platte and Elkhorn Rivers extends into adjacent associations. Some cultivated areas are used for corn and soybeans. Wooded, grassy areas are used for grazing and recreation and as wildlife habitat.

Soil blowing and droughtiness are hazards in some areas of this association. Occasional flooding and soil wetness are hazards in other areas. Good management is needed on the soils used for grazing.

The average size of farms is about 300 acres. Only a few farmsteads and roads are on this association, except where bridges span the Platte and Elkhorn Rivers. Many gravel pits are along the Platte River, but few are along the Elkhorn River. Most farm-to-market roads are gravelled and are adequate for marketing farm products within the survey area. A few highways cross the association.

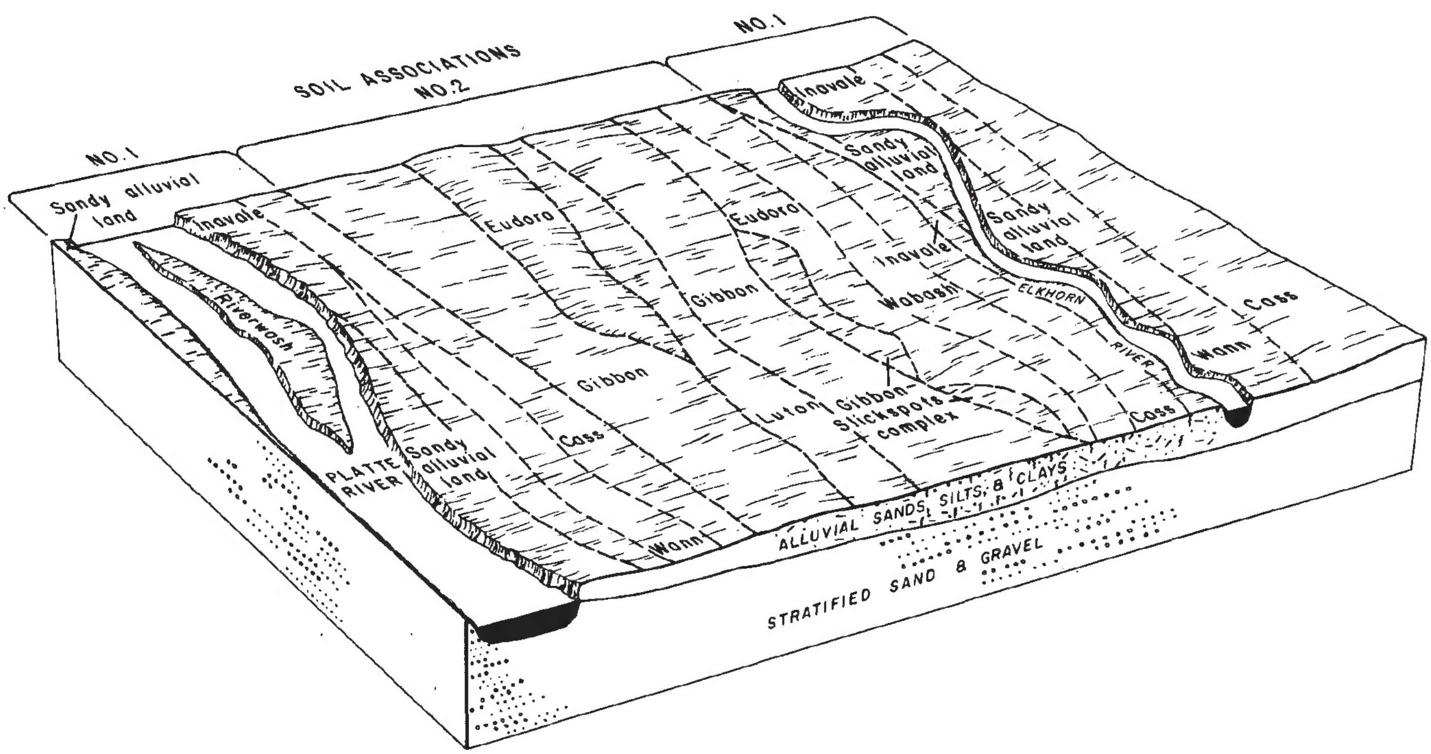


***Figure 2.*—Typical pattern of soils and underlying material in Cass-Inavale-Wann association and Gibbon-Eudora-Wabash association.**

2. Gibbon-Eudora-Wabash association

Deep, poorly drained to well-drained, nearly level silty and clayey soils on bottom land along the Platte and Elkhorn Rivers

This association (see figure 2) is on bottom land between the Platte and Elkhorn Rivers and between the bluffs and the rivers. The soils formed in medium-textured to fine-textured sediments deposited by water. In most places the water table fluctuates between depths of 2 and 10 feet.

This association makes up about 12 percent of the survey area. It is about 50 percent Gibbon soils, 9 percent Eudora soils, 7 percent Wabash soils, and 34 percent less extensive soils.

Gibbon soils are deep, nearly level, and somewhat poorly drained. Their surface layer is black silt loam and silty clay loam 16 inches thick. The transitional layer is dark-gray silt loam. The underlying material at a depth of 26 inches is grayish-brown silt loam. It becomes increasingly lighter colored and coarser textured with increasing depth.

Eudora soils are on the higher part of the landscape. They are deep, nearly level, and well drained. Their surface layer is very dark gray silt loam and very fine sandy loam. The underlying material at a depth of 13 inches is grayish-brown silt loam.

Wabash soils are on the lower part of the landscape, along the Elkhorn River. They are deep, nearly level, and poorly drained. Their surface layer is black silty clay. The transitional layer is also black silty clay. The underlying material at a depth of 21 inches is black silty clay. It is lighter colored in the lower part.

Less extensive in this association are Luton and Colo soils, Gibbon loamy sand, overwash, and Wet alluvial land. Luton soils are on the lower parts of the landscape within areas of Gibbon soils. Colo soils are adjacent to old drainageways. Wet alluvial land is in the bottoms of old river channels and drainageways and in silted-in beds. Small alkali areas are common throughout areas of Gibbon, Luton, and Wabash soils.

Farms are mainly the cash-grain type. Corn, soybeans, small grain, and alfalfa are the main crops. A few small areas are in pasture.

Wetness is the main hazard in this association. Surface drainage is needed on the fine-textured soils to facilitate timely tillage.

The average size of farms is about 300 acres. Some farmsteads are in the association. The farm-to-market roads are gravel or crushed limestone and are adequate for marketing farm products within the survey area. A few paved highways cross the association.

3. Ponca-Ida association

Deep, well-drained, strongly sloping to steep silty soils on bluffs adjacent to the Elkhorn River Valley

This association is on upland bluffs. It is dissected by many drainageways and gullies. The drainageways carry surface runoff to the Elkhorn River. The soils formed in silty loess.

This association makes up about 5 percent of the survey area. It is about 39 percent Ponca soils, 13 percent Ida soils, and 48 percent less extensive soils.

Ponca soils are on bluffs. They are deep, strongly sloping to moderately steep, and well drained. Their surface layer is very dark grayish-brown silty clay loam. The subsoil is brown silty clay loam. The underlying material at a depth of 24 inches is yellowish-brown light silty clay loam.

Ida soils are on the narrow ridgetops and ridge points and on sides of ridges bordering intermittent drainageways. They are deep, strongly sloping to steep, calcareous, and well drained. Their surface layer is dark-brown silt loam. The underlying material is grayish-brown and brown silt loam.

Less extensive in this association are Judson and Steinauer soils and Gullied land. Judson soils are at the base of slopes. Steinauer soils are commonly at mid-slope in the more steeply sloping areas. Gullied land is throughout the association in drainageways that have been severely eroded by water. The gullies are generally 6 to 25 feet deep.

Farms are generally diversified, mainly combination cash-grain and livestock type. Small areas that are not so steep are cultivated, but most of this association is steeper and is in grass, scattered trees, and brush. Most farms extend into the Gibbon-Eudora-Wabash association, the Marshall-Ponca association, or both. Because of urban expansion, some areas have been developed for housing. These areas have a desirable view, secluded wooded areas, and access to the city of Omaha. Some exclusive homes overlook the Elkhorn and Platte River Valleys.

Water erosion is the main hazard in cultivated areas. Surface runoff is the main hazard in steeper areas of pasture. Good management is needed on the soils used for grazing.

The average size of farms is about 200 acres. Only a few farmsteads are in this association. Major roads follow the ridgetops, and scattered roads lead up from the base of the hills to the ridgetops. The roads are gravel or crushed limestone and are adequate for marketing farm products within the survey area.

4. Marshall-Ponca association

Deep, well-drained, nearly level to moderately steep silty soils on loess uplands

This association (fig. 3) is mainly on uplands that have alternating divides and drainageways. Soils on the divides are nearly level to moderately sloping, and those along drainageways are moderately steep.

This association makes up about 50 percent of the survey area. It is about 57 percent Marshall soils, 19 percent Ponca soils, and 24 percent less extensive soils and land types.

Marshall soils are deep, nearly level to strongly sloping, and well drained. Their surface layer is very dark brown silty clay loam. The subsoil is dark-brown and dark yellowish-brown silty clay loam. The underlying material, at a depth of 39 inches, is light yellowish-brown silty clay loam.

Ponca soils are along drainageways. They are deep, moderately sloping to moderately steep, and well drained. Their surface layer is very dark grayish-brown silty clay loam. The subsoil is brown silty clay loam. The underlying material at a depth of 24 inches is yellowish-brown, calcareous light silty clay loam.

Less extensive in this association are Colo, Kennebec, Judson, Ida, and Steinauer soils and Gullied land and Silty alluvial land. Colo and Kennebec soils are on bottoms

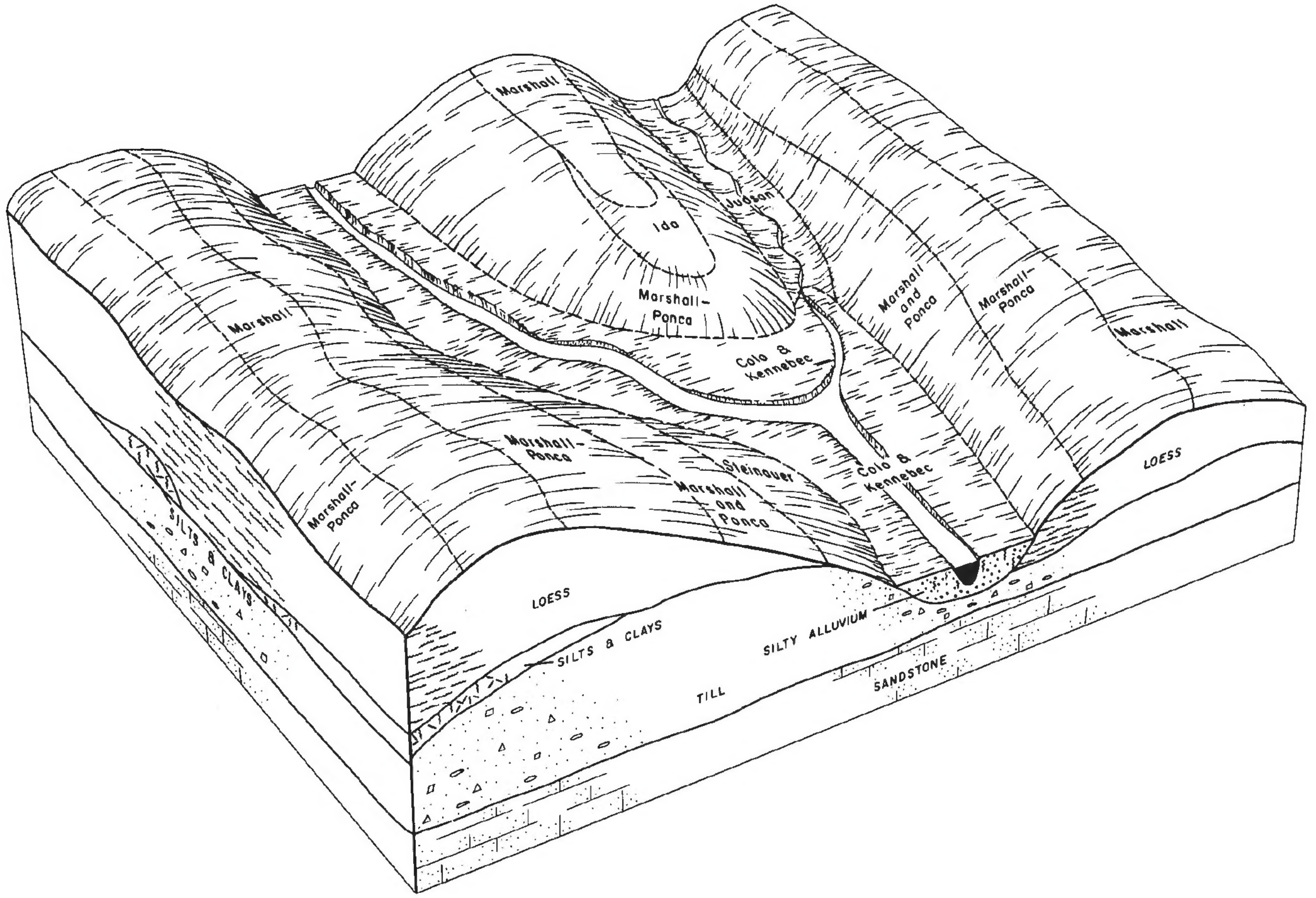


Figure 3.—**Typical pattern of soils and underlying material in Marshall-Ponca association.**

of large, nearly level drainageways. Judson soils are at the base of slopes and smaller drainageways. Steinauer soils are steeper and are above the base of the slope. Gullied land is scattered throughout this association in drainageways that have been excessively eroded by water. Silty alluvial land is along streams and wet drainageways.

Most farms are diversified, mainly a combination cash-grain and livestock type. Most soils in the association are cultivated. The main crops are corn, soybeans, small grain, grain sorghum, and alfalfa. A few small areas are in pasture.

Water erosion is the main hazard. During years of below average rainfall, sufficient moisture is not available in places for maximum production of crops.

The average size of farms is about 320 acres. Most of the farmsteads in the survey area are in this association. Farm-to-market roads are on most section lines and are generally paved, good gravel, or crushed limestone. Farm produce is marketed mainly within the survey area.

5. *Monona-Ida association*

Deep, well-drained, nearly level to very steep silty soils on bluffs adjacent to the Missouri River Valley

This association (fig. 4) is on upland bluffs. The bluffs are dissected by many drainageways and gullies. The surface drainage pattern moves surface water to the Missouri River Valley. The soils formed in silty loess deposited by wind.

This association makes up about 25 percent of the survey area. It is about 51 percent Monona soils, 9 percent Ida soils, and 40 percent less extensive soils and land types.

Monona soils are in the bluff area. They are deep, nearly level to very steep, and well drained. Their surface layer is very dark grayish-brown silt loam. The subsoil is dark-brown and yellowish-brown silt loam. The underlying material, at a depth of 33 inches, is yellowish-brown silt loam.

Ida soils are on narrow ridgetops and on sides of ridges bordering intermittent drainageways. They are deep, strongly sloping to very steep, calcareous, and well drained. Their surface layer is dark-brown silt loam. The underlying material is grayish-brown and brown silt loam.

Less extensive in this association are Judson, Kennebec, and Steinauer soils and Gullied land. Judson soils are at the base of slopes and small drainageways. Steinauer soils are steep and are above the base of slopes. Gullied land is throughout this association in drainageways that have been severely eroded by water.

Most farms are of the cash-grain type. Many of the less sloping soils are cultivated. Corn and soybeans are the

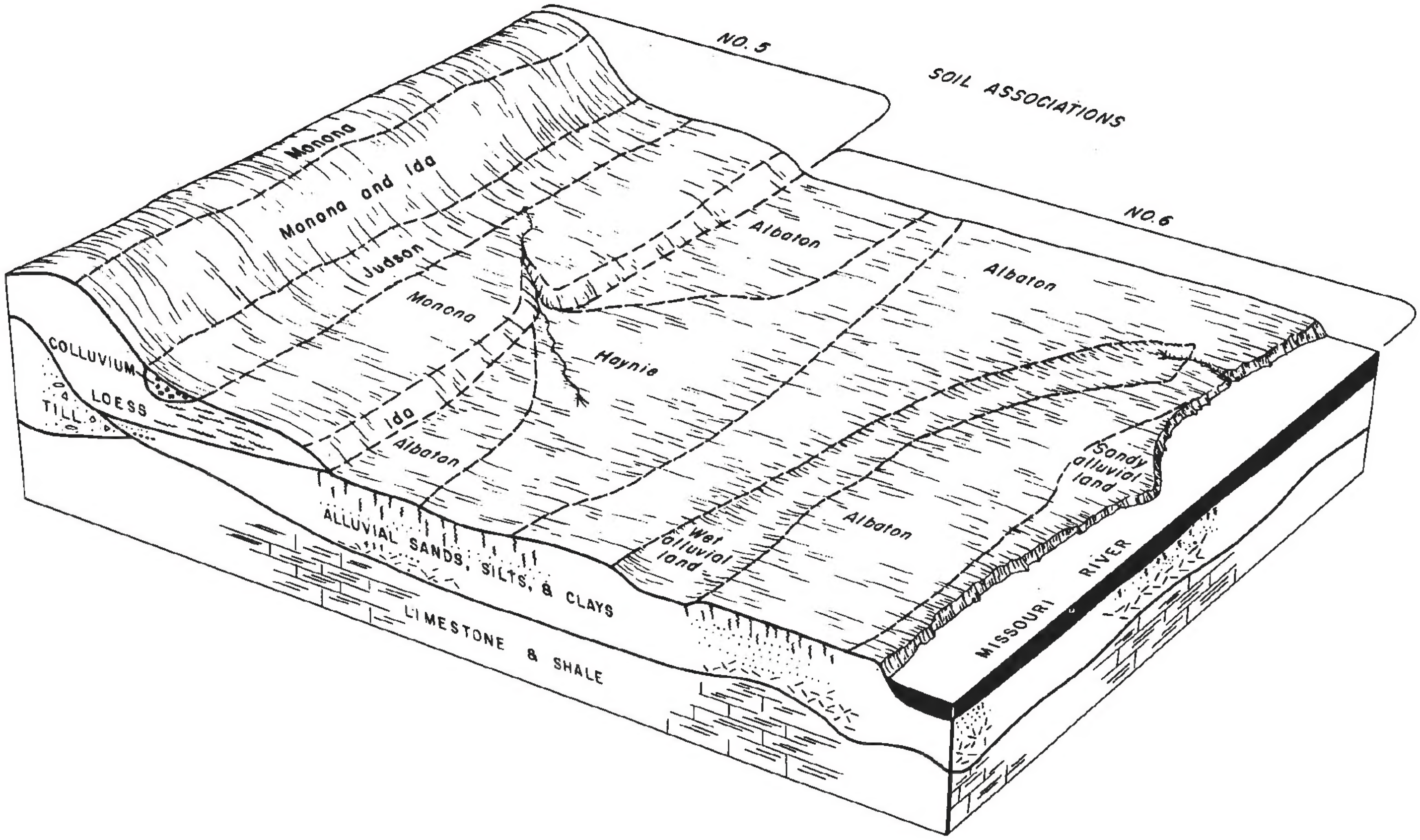


***Figure 4.*—Typical pattern of soils and underlying material in the Monona-Ida association and Albaton-Haynie association.**

main crops. The steeper soils generally are not cultivated and are in grass, scattered trees, and brush. Much of this area is in county and city parks or small acreages used for suburban homesites. Fontenelle Forest is a part of this association.

Water erosion is the main hazard in cultivated areas and in areas being developed for urban expansion.

The average size of farms is about 80 acres. Only a few farmsteads are in this association. Some roads follow the ridgetops or are along major drainageways. They either are paved or are gravel or crushed limestone. Most farm-to-market roads are on section lines. The road system is adequate for marketing farm products within the survey area.

6. *Albaton-Haynie association*

Deep, poorly drained to moderately well drained, nearly level clayey and silty soils on bottom land along the Missouri River

This association (see figure 4) is on bottom land in the Missouri River Valley. The soils formed in fine-textured and medium-textured sediments deposited by water. In most places the water table fluctuates between depths of 3 and 10 feet.

This association makes up about 4 percent of the survey area. It is about 36 percent Albaton soils, 16 percent Haynie soils, and 48 percent less extensive soils.

Albaton soils are on the lowest part of the landscape. They are deep, nearly level, and poorly drained. Their surface layer is very dark grayish-brown silty clay. The underlying material is dark grayish-brown and dark-gray silty clay.

Haynie soils are at slightly higher elevations than Albaton soils. They are deep, nearly level, and moderately well drained. Their surface layer is dark grayish-brown silt loam. The underlying material at a depth of 8 inches is dark-brown silt loam.

Less extensive in this association are Carr, Onawa, Percival, and Sarpy soils and Sandy alluvial land and Wet alluvial land. Carr soils are on the higher parts of the landscape and are moderately well drained. Onawa and Percival soils are in old, wide channels and are somewhat poorly drained. Sarpy soils are along the Missouri River and are excessively drained. Sandy alluvial land is adjacent to the river and is subject to occasional flooding. Wet alluvial land, at the lowest elevation, is on the bottom of old river channels.

Farms are mainly of the cash-grain type. Corn and soybeans are the principal crops. Some farms are more diversified, and cattle are raised. Most of the acreage is cultivated except for areas near Omaha and some industrial parks. Some areas along the river are wooded.

Wetness and occasional flooding are the main hazards. Flooding was a severe hazard before dikes were built along the Missouri River. Surface drainage is needed on the fine-textured soils to facilitate timely tillage.

The average size of farms is about 400 acres. Only a few farmsteads are in this association. Few roads are on section lines. Most roads are gravel or crushed limestone and

are adequate for marketing farm products within the survey area.

Descriptions of the Soils

This section describes the soil series and mapping units in Douglas and Sarpy Counties. A soil series is described in detail, and then, briefly, each mapping unit in that series. Unless specifically mentioned otherwise, it is to be assumed that statements about the soil series hold true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Color terms given in the descriptions are for moist soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Rock land, for example, does not belong to a soil series, but nevertheless, is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak suitability group to which the mapping unit has been assigned. The page for the description of each capability unit, range site, and windbreak suitability group can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*4*).[2]

A given soil series in these counties may be identified by a different name in a recently published soil survey of an adjacent county. Some soil boundaries may not match adjoining areas. Such differences result from changes in concepts of soil classification that have occurred since publication.

Albaton Series

The Albaton series consists of deep, nearly level, poorly drained soil on bottom lands in the Missouri River Valley. These soils formed in recently deposited clayey sediments. They generally are protected by dikes along the river, but in places occasionally are flooded by tributary streams. They are calcareous throughout. Depth to the water table ranges from 3 to 8 feet.

In a representative profile the surface layer is very dark grayish-brown silty clay about 6 inches thick. The underlying material is very sticky silty clay. It is dark grayish brown in the upper 4 inches and dark gray in the lower 50 inches. Mottles are below a depth of 10 inches.

Very slow permeability and poor surface drainage make management of these soils difficult. Available water capacity is moderate. The soils are mildly alkaline throughout. Moisture is released slowly to plants.

Albaton soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Albaton silty clay in a cultivated field 0.1 mile south and 0.3 mile east of the northwest corner of sec. 10, T. 16 N., R. 13 E.:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silty clay, gray (10YR 5/1) dry; weak, fine, granular structure; hard, very sticky; violent effervescence; mildly alkaline; abrupt, smooth boundary.

C1—6 to 10 inches, dark grayish-brown (10YR 4/2) silty clay, light brownish gray (10YR 6/2) dry; weak, coarse, prismatic structure parting to medium and coarse blocky; hard, very sticky; violent effervescence; mildly alkaline; clear, wavy boundary.

C2—10 to 29 inches, dark-gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; many, large, reddish-brown (5YR 4/3) mottles; strong, coarse and medium, blocky structure parting to strong, medium and fine, blocky; hard, very sticky; violent effervescence; mildly alkaline; clear, wavy boundary.

C3—29 to 60 inches, dark-gray (10YR 4/1) silty clay, gray (10YR 6/1) dry; many, large, reddish-brown (5YR 4/3) mottles; massive; hard, very sticky; violent effervescence; mildly alkaline.

The A horizon ranges from 6 to 20 inches in thickness. It is silty clay, silty clay loam, or silt loam.

Albaton soils are near Haynie and Carr soils and Wet alluvial land. They are finer textured than Haynie soils, which are medium textured, and Carr soils, which are moderately coarse textured above a depth of 36 inches. They are better drained than Wet alluvial land.

Albaton silty clay (0 to 1 percent slopes) (Ac).—This soil is on bottom lands in the Missouri River Valley. In places, it is in old abandoned channels of the river. It has the profile described as representative of the series. Areas range from 10 to 200 acres in size.

Included with this soil in mapping were a few areas where the surface layer is silty clay loam or silt loam. Also included were small areas of Wet alluvial land and small areas of former river channels where coarse sand is at a depth of 18 to 24 inches.

This soil is difficult to till and has slow runoff. After rains, surface water stands in depressions and low areas for several days, and tillage is delayed. During periods of high rainfall, water from side drainageways occasionally floods these low areas. The soil is generally plowed in the fall. Soil blowing can be a hazard during winter if the snow cover is not adequate. Organic-matter content is low.

Most of the acreage is in cultivated crops, mainly corn, wheat, and soybeans. Small acreages are in grain sorghum and alfalfa. Small areas adjacent to the Missouri River are wooded, mostly in cottonwood. These wooded areas have special value for recreation, mainly during the hunt-

[2] Italic numbers in parentheses refer to Literature Cited, p. 77.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Mapping unit	Douglas County		Sarpy County		Total survey area	
	Area	Extent	Area	Extent	Area	Extent
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Albaton silt loam, overwash	686	0.3	240	0.2	926	0.3
Albaton silty clay	2,412	1.1	2,012	1.3	4,424	1.2
Alda fine sandy loam	690	.3	13	[1]	703	.2
Alda very fine sandy loam	2,285	1.1	25	[1]	2,310	.6
Carr fine sandy loam	1,008	.5	608	.4	1,616	.4
Cass fine sandy loam	1,027	.5	778	.5	1,805	.5
Cass fine sandy loam, loamy substratum	809	.4	296	.2	1,105	.3
Cass very fine sandy loam	1,228	.6	991	.7	2,219	.6
Colo silty clay loam	822	.4	376	.2	1,198	.3
Colo and Kennebec soils	5,528	2.6	7,851	5.2	13,379	3.7
Cut and fill land	2,810	1.3	1,781	1.2	4,591	1.3
Dickinson soils, 11 to 17 percent slopes			335	.2	335	[1]
Eudora silt loam	3,944	1.9	4	[1]	3,948	1.1
Gibbon loamy sand, overwash	64	[1]	1,084	.7	1,148	.3
Gibbon silt loam	12,283	5.8	2,991	2.0	15,274	4.2
Gibbon silty clay loam	3,842	1.8	1,281	.8	5,123	1.4
Gibbon-Slickspots complex	266	.1			266	[1]
Gullied land	1,973	.9	565	.4	2,538	.7
Haynie silt loam	1,391	.7	848	.6	2,239	.6
Ida silt loam, 7 to 17 percent slopes, eroded	749	.4	2,184	1.4	2,933	.8
Ida silt loam, 17 to 30 percent slopes	1,085	.5	741	.5	1,826	.5
Ida silt loam, 17 to 30 percent slopes, eroded	681	.3	466	.3	1,147	.3
Inavale loamy fine sand	3,259	1.5	883	.6	4,142	1.1
Inavale loamy fine sand, hummocky	796	.4	20	[1]	816	.2
Judson silt loam, 3 to 7 percent slopes	15,206	7.2	10,844	7.2	26,050	7.1
Kennebec silt loam, occasionally flooded	8,042	3.8	6,432	4.3	14,474	4.0
Lex soils, noncalcareous variant	2,209	1.0	643	.4	2,852	.8
Luton silt loam, overwash	771	.4	96	.1	867	.2
Luton silty clay loam	838	.4	330	.2	1,168	.3
Luton silty clay	515	.2	101	.1	616	.2
Marshall silty clay loam, 0 to 1 percent slopes	4,022	1.9	160	.1	4,182	1.1
Marshall silty clay loam, 1 to 3 percent slopes	1,030	.5	844	.6	1,874	.5
Marshall silty clay loam, 3 to 7 percent slopes	17,548	8.0	24,716	15.8	42,264	11.2
Marshall silty clay loam, 3 to 7 percent slopes, eroded	2,017	.9	504	.3	2,521	.7
Marshall silty clay loam, 7 to 11 percent slopes	7,260	3.4	12,701	8.4	19,961	5.5
Marshall-Ponca silty clay loams, 7 to 11 percent slopes, eroded	15,622	7.3	31,752	20.5	47,374	12.8
Marshall and Ponca soils, 11 to 17 percent slopes	2,423	1.1	1,043	.7	3,466	1.0
Marshall and Ponca soils, 11 to 17 percent slopes, eroded	17,468	7.9	3,849	2.6	21,317	5.7
Monona silt loam, 0 to 1 percent slopes	1,661	.8	443	.3	2,104	.5
Monona silt loam, 1 to 3 percent slopes	338	.2	413	.3	751	.2
Monona silt loam, 3 to 7 percent slopes	8,539	4.0	2,135	1.4	10,674	2.9
Monona silt loam, 3 to 7 percent slopes, eroded	555	.3	65	[1]	620	.2
Monona silt loam, 7 to 11 percent slopes	7,768	3.6	2,327	1.5	10,095	2.8
Monona silt loam, 7 to 11 percent slopes, eroded	3,654	1.6	3,152	2.1	6,806	1.9
Monona silt loam, 11 to 17 percent slopes	13,679	6.4	1,437	1.0	15,116	4.2
Monona and Ida silt loams, 11 to 17 percent slopes, eroded	7,848	3.7	3,506	2.3	11,354	3.1
Monona and Ida silt loams, 17 to 30 percent slopes	2,536	1.1	1,197	.8	3,733	1.0
Monona and Ida silt loams, 17 to 30 percent slopes, eroded	2,712	1.3	144	.1	2,856	.8
Monona and Ida silt loams, 30 to 60 percent slopes			2,297	1.5	2,297	.6
Onawa silty clay			987	.7	987	.3
Percival silty clay			947	.6	947	.3
Pits and dumps	749	.4	1,281	.8	2,030	.6
Platte soils	264	.1	1,769	1.2	2,033	.6
Ponca and Ida silt loams, 7 to 11 percent slopes, eroded	1,117	.5	1,824	1.2	2,941	.8
Ponca and Ida silt loams, 11 to 17 percent slopes, eroded	1,607	.8	1,712	1.1	3,319	.9
Riverwash	584	.3	424	.3	1,008	.3
Rock land			342	.2	342	.1
Rough broken land, loess	450	.2	682	.5	1,132	.3
Sandy alluvial land	3,958	1.9	1,372	.9	5,330	1.5
Sarpy fine sand	248	.1	831	.6	1,079	.3
Silty alluvial land	444	.2	1,291	.9	1,735	.5
Steinauer clay loam, 11 to 30 percent slopes, eroded	475	.2	203	.1	678	.2
Wabash silt loam	860	.4	58	[1]	918	.3

See footnote at end of table.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

Mapping unit	Douglas County		Sarpy County		Total survey area	
	Area	Extent	Area	Extent	Area	Extent
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Wabash silty clay	2, 295	1. 1	88	0. 1	2, 383	0. 7
Wann fine sandy loam	3, 218	1. 5	955	. 6	4, 173	1. 1
Wet alluvial land	1, 328	. 6	377	. 2	1, 705	. 5
Water less than 40 acres	2, 712	1. 3	57	(1)	2, 769	. 8
Total land area	214, 208	100. 0	152, 704	100. 0	366, 912	100. 0
Water greater than 40 acres	5, 240		6, 000		11, 240	
Total area	219, 448		158, 704		378, 152	

[1] Less than 0.05 percent.

ing season. They also provide trails for riding horseback and hunting mushrooms. Capability unit IIIw-1; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Albaton silt loam, overwash (0 to 1 percent slopes) (Ab).—This soil generally is in areas occasionally flooded by water from tributary streams or by water from drainageways that originate in the adjacent bluff area. It has a profile similar to that described as representative of the series, but 10 to 20 inches of recent silt loam alluvium has been deposited on the surface. Areas range from 10 to 50 acres in size.

Included with this soil in mapping were a few areas of Albaton silty clay and Wet alluvial land.

This soil is easier to till than Albaton silty clay and has a surface layer that dries more quickly. Runoff is slow. Tillage is delayed during periods of high rainfall because the very slow permeability of the underlying material causes the surface layer to remain wet for extended periods of time. Organic-matter content is low.

Most of the acreage is in cultivated crops, mainly corn, wheat, and soybeans. Small acreages are in grain sorghum and alfalfa. Capability unit IIIw-2; Silty Overflow range site; Moderately Wet windbreak suitability group.

Alda Series

The Alda series consists of nearly level, somewhat poorly drained, calcareous soils that are moderately deep over mixed sand and gravel. These soils are on bottom lands in the Platte and Elkhorn River Valleys. They formed in recent alluvium under the influence of a moderately high water table that is at a depth of 2 to 6 feet. Coarse sand and gravel are at depths ranging from 20 to 40 inches.

In a representative profile the surface layer is black very fine sandy loam about 13 inches thick. The transitional layer is grayish-brown, loose fine sandy loam about 7 inches thick. The underlying material, at a depth of 20 inches, is light brownish-gray coarse sand and gravel. Mottles are below a depth of 13 inches.

Permeability is moderately rapid in the transitional layer and very rapid in the mixed sand and gravel. Available water capacity is low. Moisture is released readily to plants.

Alda soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Alda very fine sandy loam in a cultivated field 240 feet north and 2,376 feet west of the southeast corner of sec. 23, T. 16 N., R. 9 E.:

Ap—0 to 5 inches, black (10YR 2/1) very fine sandy loam, dark gray (10YR 4/1) dry; weak, fine, granular structure; hard, very friable; strong effervescence; mildly alkaline; abrupt, smooth boundary.

A12—5 to 13 inches, black (10YR 2/1) very fine sandy loam, dark gray (10YR 4/1) dry; weak, coarse, subangular blocky structure parting to weak, fine and very fine, subangular blocky; hard, very friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.

AC—13 to 20 inches, grayish-brown (10YR 5/2) fine sandy loam, light gray (10YR 7/2) dry; many, medium, reddish-brown (5YR 4/3) mottles in lower part; single grained; loose, very friable; moderately alkaline; abrupt, smooth boundary.

IIC—20 to 60 inches, light brownish-gray (10YR 6/2) coarse sand and gravel, white (10YR 8/2) dry; many, medium, reddish-brown (5YR 4/3) mottles; single grained; loose; neutral.

The A horizon ranges from fine sandy loam to very fine sandy loam. Depth to mixed sand and gravel ranges from 20 to 40 inches.

Alda soils are near Wann, Inavale, and Gibbon soils. They are moderately deep over sand and gravel, in contrast with the deep Wann, Inavale, and Gibbon soils. They are not so coarse textured in the AC horizon as Inavale soils, and they are coarser textured in the AC horizon than Gibbon soils.

Alda fine sandy loam (0 to 1 percent slopes) (Af).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. The water table is at depths between 2 and 6 feet. This soil has a profile similar to that described as representative of the series, but the surface layer is fine sandy loam. Areas range from 5 to 40 acres in size.

Included with this soil in mapping were a few areas of Wann fine sandy loam and Inavale loamy fine sand.

This soil is easy to till and has slow runoff. The water table fluctuates widely. It is high in spring and falls in mid-summer during peak plant growth and evaporation. Crop production under dryland management is commonly limited by lack of water. Root growth is severely restricted by the underlying mixed coarse sand and gravel. Soil

blowing is a minor hazard on fallow land. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly corn, wheat, and soybeans. Small acreages are in grain sorghum. Capability unit IIIw-6; Subirrigated range site; Moderately Wet windbreak suitability group.

Alda very fine sandy loam (0 to 1 percent slopes) (Ag).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. The water table is at depths between 2 and 6 feet. This soil has the profile described as representative of the series. Areas range from 5 to 50 acres in size.

Included with this soil in mapping were a few areas of Wann fine sandy loam and Inavale loamy fine sand.

This soil is easy to till. The water table is high in the spring and then falls in mid-summer during peak plant growth and evaporation. Crop production under dryland management is commonly limited by lack of water. Root growth is severely restricted by the underlying mixed coarse sand and gravel. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly corn, wheat, and soybeans. Small acreages are in grain sorghum. Capability unit IIIw-4; Subirrigated range site; Moderately Wet windbreak suitability group.

Carr Series

The Carr series consists of deep, nearly level, moderately well drained soils on bottom lands in the Missouri River Valley. These soils formed in recently deposited, calcareous, loamy alluvium. Dikes along the river generally protect these soils from flooding, but in places small tributary streams flood during periods of high rainfall. Depth to the water table ranges from 5 to 8 feet.

In a representative profile the surface layer is very dark grayish-brown fine sandy loam about 5 inches thick. The transitional layer is grayish-brown, very friable fine sandy loam about 10 inches thick. The underlying material is grayish-brown fine sandy loam to a depth of 36 inches. Below this it is dark-gray loam over gray silty clay loam.

Permeability is moderately rapid in the upper part of the soil and moderately slow in the lower part. Available water capacity is high. The surface layer is mildly alkaline. Moisture is released readily to plants.

Carr soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for recreation.

Representative profile of Carr fine sandy loam in a cultivated field 50 feet south and 50 feet west of the northeast corner of sec. 34, T. 16 N., R. 13 E.:

Ap—0 to 5 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak, fine, granular structure; soft, very friable; violent effervescence; mildly alkaline; abrupt, smooth boundary.

AC—5 to 15 inches, grayish-brown (10YR 5/2) fine sandy loam, light gray (10YR 7/2) dry; weak, fine, granular structure; soft, very friable; violent effervescence; mildly alkaline; clear, wavy boundary.

C1—15 to 36 inches, grayish-brown (10YR 5/2) fine sandy loam, light gray (10YR 7/2) dry; few reddish-brown (5YR 4/3) mottles in lower part; massive; soft, very friable; violent effervescence; mildly alkaline; abrupt, smooth boundary.

IIC2—36 to 50 inches, dark-gray (10YR 4/1) loam, light gray (10YR 7/2) dry; common, medium, reddish-brown (5YR 4/3) mottles; massive; hard, friable; mildly alkaline; abrupt, smooth boundary.

IIC3—50 to 60 inches, gray (10YR 5/1) silty clay loam, light brownish gray (10YR 6/2) dry; many, coarse, reddish-brown (5YR 4/3) mottles; massive; hard, sticky; neutral.

The A horizon is fine sandy loam or silt loam. The C horizon is commonly highly stratified with silt loam, very fine sandy loam, or loamy fine sand.

Carr soils are near Haynie, Sarpy, and Albaton soils. They are similar in color and location on the landscape to Haynie soils, but they have a coarser textured C1 horizon than those soils. They are finer textured than Sarpy soils. They have moderately coarse textured underlying material, whereas Albaton soils have fine textured underlying material.

Carr fine sandy loam (0 to 1 percent slopes) (Ca).—This soil is on bottom lands within a few miles of the Missouri River. Areas range from 10 to 40 acres in size.

Included with this soil in mapping were a few areas where the surface layer is silt loam, areas where the underlying material is silty clay, and areas of Haynie silt loam.

This soil is easy to till and has slow runoff. It is naturally deficient in phosphorus and nitrogen. Soil blowing is a hazard. Organic-matter content is low.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and wheat. Small acreages are in grain sorghum. Capability unit IIs-6; Sandy Lowland range site; Sandy windbreak suitability group.

Cass Series

The Cass series consists of deep, nearly level, well-drained soils on bottom lands in the Platte and Elkhorn River Valleys. Depth to the water table ranges from 6 to 10 feet.

In a representative profile the surface layer is fine sandy loam 16 inches thick. It is very dark brown in the upper part and black in the lower part. The transitional layer is very dark brown, very friable fine sandy loam 4 inches thick. The underlying material is dark grayish-brown fine sandy loam in the upper 11 inches, dark grayish-brown, loose loamy very fine sand in the next 8 inches, and brown medium and coarse sand in the lower part.

Permeability is moderately rapid, and available water capacity is moderate. The soils are slightly acid to neutral. Moisture is released readily to plants. These soils are rarely flooded except during years of extremely high rainfall.

Cass soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Cass fine sandy loam in a cultivated field 180 feet south and 1,845 feet west of the northeast corner of sec. 32, T. 16 N., R. 10 E.:

Ap—0 to 6 inches, very dark brown (10YR 2/2) fine sandy loam, gray (10YR 5/1) dry; weak, fine and very fine, granular structure; slightly hard, very friable; medium acid; abrupt, smooth boundary.

A12—6 to 16 inches, black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak, medium and coarse, subangular blocky structure parting to weak, fine, granular; slightly hard, very friable; medium acid; abrupt, smooth boundary.

AC—16 to 20 inches, very dark brown (10YR 2/2) fine sandy loam, gray (10YR 5/1) dry; weak, coarse, subangular blocky structure parting to weak, fine, granular; slightly hard, very friable; slightly acid; abrupt, smooth boundary.

C1—20 to 31 inches, dark grayish-brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) dry; single grained; loose; slightly acid; abrupt, smooth boundary.

C2—31 to 39 inches, dark grayish-brown (10YR 4/2) loamy very fine sand, light gray (10YR 7/2) dry; single grained; loose; neutral; abrupt, smooth boundary.

IIC3—39 to 60 inches, brown (10YR 5/3) medium and coarse sand, white (10YR 8/2) dry; single grained; loose; neutral.

The A horizon is fine sandy loam or very fine sandy loam. The C horizon in some areas is silty clay or silty clay loam at a depth of 38 to 48 inches.

Cass soils are near Gibbon, Inavale, and Wann soils. They are coarser textured in the upper part of the C horizon than Gibbon soils. They have a thicker, darker colored A horizon than Inavale soils, and they are not so coarse textured in the AC and C1 horizons as those soils. They have a lower water table than Wann soils and are better drained.

Cass fine sandy loam, loamy substratum (0 to 1 percent slopes) (Cd).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. It is in the higher part of the landscape. This soil has a profile similar to that described as representative of the series, but it has a silty clay loam substratum between depths of 30 and 48 inches.

Included with this soil in mapping were small areas of Cass very fine sandy loam and Cass fine sandy loam.

This soil is easy to till and has slow runoff. It is naturally deficient in phosphorus and nitrogen. During periods of high rainfall or of irrigation, it can hold more water in the transitional layer and surface layer because it has a loamy substratum. Soil blowing is a hazard. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly corn and soybeans. Small acreages are in wheat and grain sorghum. Capability unit IIs–6; Sandy Lowland range site; Sandy windbreak suitability group.

Cass fine sandy loam (0 to 1 percent slopes) (Cc).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. It is nearly level, except for a few areas on ridges and the sides of shallow channels. It is in the higher part of the landscape. It has the profile described as representative of the series. Areas range from 10 to 50 acres in size.

Included with this soil in mapping were a few areas of Cass very fine sandy loam and Cass fine sandy loam, loamy substratum.

This soil is easy to till and has slow runoff. It is naturally deficient in phosphorus and nitrogen. Soil blowing is a hazard. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly corn and soybeans. Small acreages are in wheat and grain sorghum. Capability unit IIs–6; Sandy Lowland range site; Sandy windbreak suitability group.

Cass very fine sandy loam (0 to 1 percent slopes) (Ce).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. It is on the higher part of the flood plain. It has a profile similar to that described as representative of the series, but the surface layer is very fine sandy loam. Areas range from 10 acres to 100 acres in size.

Included with this soil in mapping were a few areas of Cass fine sandy loam and Cass fine sandy loam, loamy substratum.

This soil has moderate organic-matter content, good tilth and workability, and slow runoff. It is a productive soil even though it is naturally deficient in phosphorus and nitrogen.

Most of the acreage is in cultivated crops, mainly corn and soybeans. Small acreages are in grain sorghum, wheat, and alfalfa. Capability unit I–1; Sandy Lowland range site; Silty to Clayey windbreak suitability group.

Colo Series

The Colo series consists of deep, nearly level, somewhat poorly drained soils on bottom lands in the Platte and Elkhorn River Valleys and on bottom lands along Big Papillion Creek and its tributaries. The water table is at a depth ranging from 3 to 8 feet. These soils flood occasionally.

In a representative profile the surface layer is black silty clay loam about 29 inches thick. Beneath this is very dark grayish-brown light silty clay loam about 11 inches thick. The underlying material, at a depth of 40 inches, is dark gray. It is silt loam in the upper part and fine sandy loam in the lower part.

Permeability is moderately slow, and available water capacity is high. The soils are neutral to medium acid. Moisture is released slowly to plants.

Colo soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Colo silty clay loam in a cultivated field 0.2 mile north of center of sec. 11, T. 15 N., R. 10 E.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak, fine, granular structure; hard, firm; medium acid; abrupt, smooth boundary.

A12—8 to 23 inches, black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak, medium and coarse, subangular blocky structure parting to strong, fine, subangular blocky; hard, firm; slightly acid; clear, wavy boundary.

A13—23 to 29 inches, black (10YR 2/1) light silty clay loam, dark gray (10YR 4/1) dry; weak, coarse, prismatic structure parting to moderate, fine and very fine, subangular blocky structure; hard, firm; slightly acid; clear, wavy boundary.

AC—29 to 40 inches, very dark grayish-brown (10YR 3/2) light silty clay loam, dark gray (10YR 4/1) dry; many, medium, reddish-brown (5YR 4/3) mottles; weak, coarse, prismatic structure parting to massive; hard, friable; slightly acid; abrupt, smooth boundary.

C1—40 to 55 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 5/1) dry; many coarse, reddish-brown (5YR 4/3) mottles; massive; slightly hard, very friable; neutral; abrupt, smooth boundary.

C2—55 to 60 inches, dark-gray (10YR 4/1) fine sandy loam, light brownish gray (10YR 6/2) dry; many, coarse, reddish-brown (5YR 4/3) mottles; massive; slightly hard, very friable; neutral.

In some areas, grayish-brown silty sediment is 6 to 18 inches thick above the dark A horizon. The A horizon is typically silty clay loam, but ranges to heavy silt loam. The solum is about 36 to 50 inches thick.

Colo soils are near Gibbon, Kennebec, Luton, and Wabash soils. They are noncalcareous, in contrast with Gibbon soils, which are calcareous at the surface. They are somewhat poorly drained, in contrast with Kennebec soils, which are well drained. They are not so fine textured as Luton and Wabash soils.

Colo silty clay loam (0 to 1 percent slopes) (Cg).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. It is on low areas adjacent to old river channels. It has the profile described as representative of the series. Areas range from 10 to 50 acres in size.

Included with this soil in mapping were a few areas of Gibbon silty clay loam, Gibbon silt loam, and Luton silty clay loam.

This soil is fairly easy to till and has slow runoff. The slow surface drainage causes the surface layer to remain wet for long periods of time, and as a result, tillage is delayed in spring. Organic-matter content is high.

Most of the acreage is in cultivated crops, mainly corn and soybeans. Small acreages are in grain sorghum, wheat, and alfalfa. Capability unit IIw-4; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Colo and Kennebec soils (0 to 1 percent slopes) (Ck).—These soils are on bottom lands along Big Papillion Creek and its tributaries. Most areas contain both Colo and Kennebec soils in percentages that vary from place to place. A few contain only one of these major soils. Areas range from 30 to 240 acres in size. The Kennebec soil is described under the heading "Kennebec Series."

Included with these soils in mapping were areas that are 5 to 10 percent Wabash silty clay and 2 to 5 percent Judson silt loam.

Occasional flooding and wetness are the main hazards. Runoff is slow. Organic-matter content is high. The soils are fairly easy to till.

Most areas are in cultivated crops, mainly corn and soybeans. Small acreages are in grain sorghum, wheat, and alfalfa. Capability unit IIw-3; Moderately Wet windbreak suitability group; Colo soil in Clayey Overflow range site, Kennebec soil in Silty Lowland range site.

Cut and Fill Land

Cut and fill land (0 to 30 percent slopes) (Cm) consists of areas that have been leveled or reshaped for industrial tracts or other urban uses. It is mainly in and around Omaha and Bellevue where housing and industrial sites have been built. The original soils have been changed to the extent that they are no longer recognizable. In most places the landscape has also been altered. Areas range from 5 to 400 acres in size.

The soil material is mainly medium textured to moderately fine textured. In some areas the entire soil profile has been removed, and the present surface is exposed material of Loveland Loess or bedrock of. the Dakota Sandstone Formation.

Included in mapping were some areas of fill where cement, bricks, and trash were covered with soil and then compacted and leveled. These areas are now used as building sites, railroad yards, and parks.

Erosion is the main hazard in the new cut or fill areas. Onsite investigation is needed before any engineering, urban, or recreation use, because disturbance results in variable soil and physical conditions. No capability unit, range site, or windbreak suitability group assigned.

Dickinson Series

The Dickinson series consists of deep, moderately steep, somewhat excessively drained soils on bluffs adjacent to the Platte River Valley. These soils formed in moderately coarse textured glacial drift or outwash and in alluvial sediments that were reworked or redeposited by wind.

In a representative profile the surface layer is fine sandy loam about 16 inches thick. It is black in the upper part, very dark brown in the middle part, and dark grayish brown in the lower part. The subsoil is dark-brown, friable fine sandy loam about 14 inches thick. The underlying material, at a depth of 30 inches, is yellowish-brown loamy sand.

Permeability is moderately rapid, and available water capacity is moderate. Moisture is released readily to plants.

Dickinson soils are too steep to be suited to cultivated crops. They are suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for recreation.

Representative profile of Dickinson fine sandy loam, 11 to 17 percent slopes, in a cultivated field 0.2 mile south and 0.2 mile west of the center of sec. 12, T. 12 N., R. 10 E.:

Ap—0 to 6 inches, black (10YR 2/1) heavy fine sandy loam, dark grayish brown (10YR 4/2) dry; weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

A12—6 to 10 inches, very dark brown (10YR 2/2) fine sandy loam, gray (10YR 5/1) dry; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; neutral; clear, wavy boundary.

A3—10 to 16 inches, dark grayish-brown (10YR 4/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak, coarse, prismatic structure parting to weak, medium and fine, subangular blocky; slightly hard, friable; slightly acid; clear, wavy boundary.

B—16 to 30 inches, dark-brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; weak, coarse, prismatic structure parting to weak, medium and fine, subangular blocky; slightly hard, friable; slightly acid; clear, wavy boundary.

C—30 to 60 inches, yellowish-brown (10YR 5/4) loamy sand, very pale brown (10YR 7/4) dry; single grained; slightly hard, friable; slightly acid.

The A horizon ranges from 10 to 20 inches in thickness. It ranges from silt loam to loamy sand. The B horizon ranges from fine sandy loam in the upper part to loamy fine sand, loamy sand, or fine sand in the lower part. The C horizon is loamy fine sand, loamy sand, or fine sand.

Dickinson soils are near Marshall and Monona soils and Rock land. They have a higher content of sand and contain less clay in the solum than Marshall or Monona soils. They are deep, moderately coarse textured soils that have little resemblance to Rock land, which is mainly bedrock outcrops.

Dickinson soils, 11 to 17 percent slopes (DcE).—These soils are just above the steep slopes and entrenched drainageways of the Platte River Bluffs. They are along the ridges. Their surface layer ranges from silt loam to loamy sand. Areas range from 5 to 15 acres in size.

Included with these soils in mapping were small areas of sandy glacial till and outcrops of Dakota sandstone. Also included were small areas of Marshall silty clay loam and Monona silt loam. In some areas the surface layer is thinner and lighter colored than is typical.

If cultivated, these soils tend to be droughty. They are naturally deficient in phosphorus and nitrogen. Runoff is medium. Erosion is the main hazard. Organic-matter content is moderate.

Most of the acreage is in grass and trees, mainly bluegrass and bromegrass and cedar and oak trees. Capability unit VIe-3; Sandy range site; Sandy windbreak suitability group.

Eudora Series

The Eudora series consists of deep, nearly level, well-drained soils on bottom lands in the Platte and Elkhorn River Valleys.

In a representative profile the surface layer is about 13 inches thick. The upper part is very dark gray silt loam, and the lower part is very dark grayish-brown very fine sandy loam. The underlying material is grayish-brown silt loam to a depth of 58 inches. Below this, it is grayish-brown very fine sand.

Permeability is moderate, and available water capacity is high. Moisture is released readily to plants.

Eudora soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Eudora silt loam in a cultivated field 2,112 feet south and 120 feet west of the northeast corner of sec. 9, T. 16 N., R. 9 E.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak, fine, granular structure; hard, very friable; abrupt, smooth boundary.

A12—7 to 13 inches, very dark grayish-brown (10YR 3/2) very fine sandy loam, gray (10YR 5/1) dry; weak, medium, subangular blocky structure parting to weak, fine and very fine, subangular blocky; hard, very friable; abrupt, smooth boundary.

C1—13 to 32 inches, grayish-brown (10YR 5/2) silt loam, light brownish gray (10YR 6/2) dry; weak, fine, granular structure; hard, very friable; clear, wavy boundary.

C2—32 to 58 inches, grayish-brown (10YR 5/2) silt loam, white (10YR 8/2) dry; massive; hard, very friable; strongly effervescent; clear, wavy boundary.

IIC3—58 to 60 inches, grayish-brown (10YR 5/2) very fine sand, light gray (10YR 7/2) dry; single grained; loose.

Dark, buried horizons are common in the C horizon. The buried horizon, if present, ranges from silty clay loam to silty clay at a depth of 30 to 42 inches. Depth to free carbonates ranges from 20 to 48 or more inches.

Eudora soils are near Cass, Gibbon, and Wabash soils. They are not so coarse in the C1 and C2 horizons as Cass soils. They are not so fine textured as Wabash soils. They have a lower water table than Gibbon soils and are leached of lime to a greater depth.

Eudora silt loam (0 to 1 percent slopes) (Ed).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. It is on the highest part of the landscape adjacent to old stream channels. Areas range from 10 to 60 acres in size.

Included with this soil in mapping were small areas of Cass very fine sandy loam and Gibbon silt loam. Also included were small areas that have a very fine sandy loam surface layer.

This soil is among the most productive in the survey area. It is easy to till, takes in and stores moisture well, and has slow runoff. It is little affected by water erosion or soil blowing. Organic matter content is high. Nitrogen and phosphate are needed for maximum production.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum and wheat. Capability unit I-1; Silty Overflow range site; Silty to Clayey windbreak suitability group.

Gibbon Series

The Gibbon series consists of deep, nearly level, calcareous, somewhat poorly drained soils on bottom lands in the Platte and Elkhorn River Valleys. The depth to the water table ranges from 2 to 6 feet.

In a representative profile the surface layer is silt loam about 25 inches thick. The upper part is black, the middle part is very dark gray, and the lower part is dark gray. The underlying material, at a depth of 25 inches, is grayish-brown silt loam in the upper part, light brownish-gray silty clay loam in the middle part, and pale-brown sand in the lower part.

Permeability is moderate or moderately slow, and available water capacity is high. Moisture is released readily to plants. The surface layer is mildly alkaline to moderately alkaline.

Gibbon soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Gibbon silt loam in a cultivated field 60 feet south and 2,112 feet west of the northeast corner of sec. 24, T. 16 N., R. 9 E.:

Ap—0 to 7 inches, black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak, fine, granular structure; slightly hard, friable; violent effervescence; mildly alkaline; abrupt, smooth boundary.

A12—7 to 16 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak, medium and fine, granular structure; slightly hard, very friable; violent effervescence; moderately alkaline; abrupt, smooth boundary.

A3—16 to 25 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; weak, fine and very fine, subangular blocky structure; slightly hard, very friable; violent effervescence; moderately alkaline; clear, wavy boundary.

C1—25 to 40 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; massive; slightly hard, very friable; violent effervescence; strongly alkaline; clear, wavy boundary.

C2—40 to 54 inches, light brownish-gray (10YR 6/2) silty clay loam, white (10YR 8/2) dry; massive; hard, friable; slight effervescence; moderately alkaline; clear, wavy boundary.

IIC3—54 to 60 inches, pale-brown (10YR 6/3) sand, very pale brown (10YR 7/3) dry; single grained; loose; mildly alkaline; abrupt, smooth boundary.

The A horizon ranges from silty clay loam to loamy sand. It ranges from 8 to 25 inches in thickness. The C horizon commonly is silt loam or silty clay loam above a depth of 40 inches, but below this it ranges from silty clay loam to sand.

The Gibbon soils in this survey area have less calcium carbonate in the A3 and C1 horizon than is defined as the range for the series.

Gibbon soils are near Cass, Colo, Eudora, Luton, and Wabash soils. They have finer textured C1 and C2 horizons than Cass soils. They are not so fine textured as Luton or Wabash soils. In contrast with Colo soils, they are calcareous in the A horizon and have a lighter colored C horizon. They have a higher water table than the well-drained Eudora soils.

Gibbon loamy sand, overwash (0 to 1 percent slopes) (Ga).—This soil is on bottom lands along the Platte River. It is in low areas where ice jams caused the dikes to break and allowed the flood water to spread coarse-textured alluvial material over the original soil. This soil has a profile similar to that described as representative of the series, but it has 8 to 20 inches of recent fine sandy loam or loamy fine sand alluvium on the surface. Areas range from 5 to 40 acres in size.

Included with this soil in mapping were small areas of Gibbon silt loam.

This soil has slow runoff. Wetness is the main hazard. In spring when the water table is highest, the soils dry slowly. Tillage is commonly delayed. The soil is flooded at infrequent intervals early in spring or late in winter. When the water table is lowest, late in summer, this soil is droughty in the upper 10 to 20 inches. Soil blowing is a minor hazard in areas.

Part of the acreage is in cultivated crops, mainly corn and soybeans. Small acreages are in grain sorghum and wheat. The areas not in cultivated crops are commonly in bromegrass. Capability unit IIw–6; Subirrigated range site; Moderately Wet windbreak suitability group.

Gibbon silt loam (0 to 1 percent slopes) (Gb).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. It has the profile described as representative of the series. Areas range from 10 to 400 acres in size.

Included with this soil in mapping were small areas of Gibbon silty clay loam, areas that have a surface layer 10 to 20 inches thick over silty clay loam underlying material, and small areas of Eudora silt loam.

This soil is highly productive under a high level of management. It is easy to till and has slow runoff. It warms up later in spring than the better drained soils. Tillage and planting are commonly delayed by wetness. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Some areas are in winter wheat and grain sorghum. Capability unit IIw–4; Subirrigated range site; Moderately Wet windbreak suitability group.

Gibbon silty clay loam (0 to 1 percent slopes) (Gc).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. It is at lower elevations than Gibbon silt loam. This soil has a profile similar to the one described as representative of the series, but the surface layer is silty clay loam. Areas range from 10 to 400 acres in size.

Included with this soil in mapping were small areas of Gibbon silt loam and Colo silty clay loam and areas that have a silt loam surface layer 10 to 20 inches thick over silty clay loam underlying material. Also included were small areas of strongly alkaline soils. These areas are indicated by a special symbol on the detailed soil map.

This soil has slow runoff. Wetness is the main hazard. Tillage and planting are commonly delayed, and the soil warms up later in the spring than better drained soils. During periods of above normal rainfall, this soil can be extremely wet for several days, causing crop production to be reduced. During periods of below normal rainfall, production is higher than on better drained soils. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Some areas are in winter wheat and grain sorghum. Capability unit IIw–4; Subirrigated range site; Moderately Wet windbreak suitability group.

Gibbon-Slickspots complex (0 to 1 percent slopes) (Gs).—This complex of soils is on bottom lands in the Platte and Elkhorn River Valleys. It is in slight depressions and on higher ridges where it is associated with Gibbon, Luton, and Wabash soils. Most areas are about 60 percent Gibbon soils and 30 percent Slickspots. Some are as much as 75 percent Slickspots, and others, as little as 15 percent. Areas range from 5 to 20 acres in size.

The Gibbon soil has a profile similar to the one described as representative of the Gibbon series, but the underlying material is slightly finer textured and has a moderate to high accumulation of salts. The Slickspots part of this complex is described under the heading "Slickspots."

Included with these soils in mapping were small areas of Gibbon silt loam, Gibbon silty clay loam, Luton silty clay, and Wabash silty clay.

Salinity and alkalinity are the main hazards. Runoff is slow. The lowest areas are ponded. Soil structure has been destroyed because salts accumulate and because the soil is commonly tilled when wet. The Slickspots part of this complex releases moisture slowly to plants and is droughty. Organic-matter content is low.

Most of the acreage is in cultivated crops, mainly grain sorghum and winter wheat. Crops that tolerate salts and alkali are best suited. Corn, soybeans, and alfalfa are not well suited. Capability unit IVs–1; Moderately Saline or Alkali windbreak suitability group; Gibbon soil in Subirrigated range site, Slickspots in Saline Lowland range site.

Gullied Land

Gullied land (30 to 100 percent slopes) (Gu) consists of areas along drainageways that have been deeply cut by gully erosion. In some areas, drainage channels were cut through low bottom lands, and the channels are 4 to 35 feet below the original level of the stream. These areas are long and narrow and range from 5 to 10 acres in size. The soil material is mainly medium textured to moderately fine textured.

Included in mapping were small areas of Judson silt loam, 3 to 7 percent slopes, and Kennebec silt loam.

Water erosion is the main hazard. If uncontrolled, degrading and sluffing of side banks can cause gullies that range from 6 to 40 feet in depth and are equally as wide. In upland areas, drainageways have been cut by erosion during periods of high rainfall and excessive runoff.

Gullied land is too steep to be suited to cultivation or grazing. Trees and brush cover many areas and help to stabilize the eroding banks. Capability unit VIIe–1; Thin Loess range site; Undesirable windbreak suitability group.

Haynie Series

The Haynie series consists of deep, moderately well drained soils on low bottom lands in the Missouri River Valley. These soils formed in recently deposited, calcareous, silty alluvium that is commonly stratified with thin layers of clay loam and sandy loam. They are nearly level, but are cut by a few channels. They are occasionally flooded. Depth to the water table ranges from 4 to 8 feet.

In a representative profile the surface layer is dark grayish-brown, calcareous silt loam about 9 inches thick. The underlying material is calcareous silt loam. It is yellowish brown in the upper part and very dark grayish brown in the lower part.

Permeability is moderate, and available water capacity is high. Moisture is released readily to plants. The soils are mildly alkaline throughout.

Haynie soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Haynie silt loam in a cultivated field 0.1 mile west and 0.15 mile north of the center of sec. 3, T. 16 N., R. 13 E.:

Ap—0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; weak, fine, granular structure; slightly hard, very friable; violent effervescence; mildly alkaline; abrupt, smooth boundary.

C1—9 to 30 inches, yellowish-brown (10YR 5/4) silt loam, pale brown (10YR 6/3) dry; few, fine, yellowish-brown (10YR 5/8) mottles in lower part; weak, fine, granular structure; slightly hard, very friable; violent effervescence; mildly alkaline; abrupt, smooth boundary.

C2—30 to 60 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; few, fine, yellowish-brown (10YR 5/8) mottles; massive; slightly hard, very friable; violent effervescence; mildly alkaline.

The C horizon commonly is stratified with silt loam, very fine sandy loam, or fine sandy loam. It ranges from silt loam to silty clay loam below a depth of 40 inches.

Haynie soils are near Albaton, Carr, Onawa, and Percival soils and Wet alluvial land. They are not so fine textured as Albaton soils. They are finer textured than Carr soils. They are coarser textured in the C horizon than Onawa soils. They are not so coarse textured in the C horizon as Percival soils. They are better drained than Wet alluvial land.

Haynie silt loam (0 to 1 percent slopes) (Ha).—This soil is on bottom lands in the Missouri River Valley. It is on the low part of the landscape and is occasionally flooded by upland tributary streams that drain into the bottom lands. Areas range from 10 to 160 acres in size.

Included with this soil in mapping were small areas of Carr fine sandy loam.

This is a productive soil. It is easy to till. It takes in and stores moisture well, has slow runoff, and is little affected by water erosion and soil blowing. The water table is highest early in spring when water is released from reservoirs upstream to make the Missouri River navigable, but it drops to a depth of more than 6 feet during the growing season. Organic-matter content is low, which indicates that most likely, nitrogen is lacking in places. Lime content is high, and available phosphorus is low.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and wheat. Small acreages are in grain sorghum and alfalfa. Capability unit I–1; Silty Lowland range site; Silty to Clayey windbreak suitability group.

Ida Series

The Ida series consists of deep, strongly sloping to steep, well-drained soils on uplands. These soils are mainly on bluffs adjacent to the Missouri and Elkhorn River Valleys. They formed in silty loess.

In a representative profile the surface layer is dark-brown, calcareous silt loam about 5 inches thick. The underlying material extends to a depth of 60 inches. The upper 4 inches is very friable, grayish-brown, calcareous silt loam. The rest is brown, calcareous silt loam.

Permeability is moderate, and available water capacity is high. Moisture is released readily to plants. The surface layer is mildly alkaline, and the underlying material is moderately alkaline.

If slopes are less than 17 percent, Ida soils are suited to cultivated crops. They are suited to grass, to windbreak plantings, and to plantings for wildlife. They also provide suitable sites for some types of recreation.

Representative profile of Ida silt loam, 7 to 17 percent slopes, eroded, in a cultivated field 0.15 mile east and 0.1 mile south of the northwest corner of sec. 26, T. 16 N., R. 10 E.:

Ap—0 to 5 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak, fine, granular structure; slightly hard, very friable; violent effervescence; mildly alkaline; abrupt, smooth boundary.

C1—5 to 9 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; weak, fine, granular structure; slightly hard, very friable; few lime nodules; violent effervescence; moderately alkaline; clear, wavy boundary.

C2—9 to 60 inches, brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) dry; few, fine, light brownish-gray (10YR 6/2) mottles; massive; slightly hard, very friable; violent effervescence; moderately alkaline.

The A horizon ranges from 4 to 8 inches in thickness. Hard spherical nodules and soft lime are in all layers below the A horizon.

Ida soils are near Marshall, Monona, and Ponca soils. They have a thinner surface layer than Marshall and Monona soils and do not have the B horizon typical of those soils. In contrast with Ponca soils, they have lime higher in the profile, and horizons are more weakly expressed.

Ida silt loam, 7 to 17 percent slopes, eroded (IdD2).—This soil is on rounded ridgetops and sides of drainageways along bluffs adjacent to the Elkhorn and Missouri River Valleys. The surface layer is less than 6 inches thick, and much of the darkened material has been removed by sheet erosion. This soil has the profile described as representative of the series. Areas are 5 to 20 acres in size.

Included with this soil in mapping were a few areas of Ponca silt loam, 11 to 17 percent slopes, eroded, and Monona silt loam, 11 to 17 percent slopes, eroded.

This soil is easy to till and has rapid runoff. Conserving moisture is an important concern in management. Water erosion is the main hazard. Gullies and small rills are common. Organic-matter content and nitrogen content are both low. Because this soil is high in lime content, the available phosphorus is low.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and wheat. Small acreages are in grain sorghum and alfalfa. Capability unit IVe–9; Limy Upland range site; Silty to Clayey windbreak suitability group.

Ida silt loam, 17 to 30 percent slopes (IdE).—This soil is on bluffs adjacent to the Elkhorn and Platte River Valleys. The surface layer is about 6 inches thick. This soil has a profile similar to that described as representative of the series, but the surface layer is several inches thicker and lime is at a slightly lower depth. Areas range from 10 to 40 acres in size.

Included with this soil in mapping were areas of Ida silt loam, 7 to 17 percent slopes, eroded, and Steinauer clay loam, 11 to 30 percent slopes, eroded.

Water erosion is the main hazard. Runoff is rapid. Gullies are common. Fertility is low. Conserving moisture is an important concern in management.

Most of the acreage is in native grass and trees. This soil is too steep to be suitable for cultivation. The native grass is mostly of big bluestem, little bluestem, indiangrass, sideoats grama, and switchgrass. Oaks, elms, and hackberry are the most common trees. Capability unit VIe–9; Limy Upland range site; Undesirable windbreak suitability group.

534-869 O - 75 - 2

Ida silt loam, 17 to 30 percent slopes, eroded (IdE2).—This soil is on bluffs adjacent to the Elkhorn and Platte River Valleys. It has been cultivated. The present surface layer is less than 6 inches thick. Much of the original surface layer has been removed by sheet and rill erosion, and the light-colored, calcareous substratum is exposed at the surface. Areas range from 15 to 40 acres in size.

Included with this soil in mapping were a few areas of Ida silt loam, 7 to 17 percent slopes, eroded, and Steinauer clay loam, 11 to 30 percent slopes, eroded.

Water erosion is the main hazard. Runoff is rapid. Gullies and rills are common. Fertility is low. Conserving moisture is an important concern in management.

This soil is too steep to be suited to cultivated crops. Most of the acreage is in native grass and trees. The native grass is mostly big bluestem, little bluestem, indiangrass, side-oats grama, and switchgrass. Oak, elm, and hackberry are the most common trees. Capability unit VIe-9; Limy Upland range site; Undesirable windbreak suitability group.

Inavale Series

The Inavale series consists of deep, nearly level to moderately sloping, somewhat excessively drained soils on bottom lands in the Platte and Elkhorn River Valleys. These soils formed in loamy and sandy alluvium. The water table is at a depth ranging from 5 to 10 feet.

In a representative profile the surface layer is dark grayish-brown loamy fine sand about 6 inches thick. The transitional layer is brown loamy fine sand about 5 inches thick. The underlying material is light brownish-gray loamy fine sand in the upper part, light-gray fine sand in the middle part, and pale-brown mixed sand and gravel in the lower part.

Permeability is rapid, and available water capacity is low. The soils are mildly alkaline. Moisture is released rapidly to plants.

Inavale soils are suited to cultivated crops, but their use for this purpose is marginal, particularly under dryland management. These soils are suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Inavale loamy fine sand in a cultivated field 50 feet south and 50 feet east of the northwest corner of sec. 35, T. 16 N., R. 9 E.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; single grained; loose; mildly alkaline; abrupt, smooth boundary.

AC—6 to 11 inches, brown (10YR 4/3) loamy fine sand, grayish brown (10YR 5/2) dry; single grained; loose; mildly alkaline; abrupt, smooth boundary.

C1—11 to 28 inches, light brownish-gray (10YR 6/2) loamy fine sand, light gray (10YR 7/2) dry; single grained; loose; mildly alkaline; clear, wavy boundary.

C2—28 to 51 inches, light-gray (10YR 7/2) fine sand, very pale brown (10YR 8/4) dry; single grained; loose; mildly alkaline; clear, wavy boundary.

C3—51 to 60 inches, pale-brown (10YR 6/3) sand and gravel, white (10YR 8/2) dry; many, fine, reddish-brown (5YR 4/3) mottles; single grained; loose; mildly alkaline.

The A horizon ranges from 4 to 10 inches in thickness. The C horizon is commonly loamy sand in the upper part, but ranges from fine sand to sand in the lower part. Mixed sand and gravel are below a depth of 40 inches in some places. In places the C horizon is stratified with thin layers of finer and coarser textured material.

Inavale soils are near Cass, Platte, and Wann soils. They are coarser textured in the upper part of the C horizon than Cass or Wann soils. They are deeper over sand and gravel and have a lower water table than Platte soils.

Inavale loamy fine sand (0 to 1 percent slopes) (Im).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. In many places it is adjacent to meandering stream channels. This soil has the profile described as representative of the series. Areas range from 5 to 40 acres in size.

Included with this soil in mapping were small areas that have silty clay underlying material at a depth of more than 40 inches and some areas that have a water table at a depth of less than 5 feet early in spring when the level of the river is highest. Also included were a few areas of Wann fine sandy loam and areas that have a fine sand surface layer.

Soil blowing is a major hazard if this soil is cultivated. The soil is droughty because the available water capacity is low. Organic-matter content and fertility are low. Runoff is slow to very slow. Most of the rainfall is absorbed as rapidly as it falls.

Part of the acreage is in cultivated crops, mainly corn, soybeans, and wheat. Small acreages are in grain sorghum. Some areas are in native grass. Capability unit IIIe-5; Sandy Lowland range site; Sandy windbreak suitability group.

Inavale loamy fine sand, hummocky (0 to 7 percent slopes) (In).—This soil is on bottom lands in the Platte River Valley. It is on narrow ridges that are 50 to 100 feet wide and 8 to 15 feet above the adjacent soils. This soil has a profile similar to that described as representative of the series, but the surface layer is slightly thinner. Areas range from 5 to 20 acres in size.

Included with this soil in mapping were some areas that have a fine sand surface layer.

Soil blowing is a major hazard. In areas that have been overgrazed, active blowouts are common. Maintaining an adequate cover is an important concern in management. The soil is droughty because the available water capacity is low. Organic-matter content and fertility are low. Runoff is very slow. Most of the rainfall is absorbed as rapidly as it falls.

This soil is not suited to crops. Most areas are in grass and are used for grazing. Many areas are used for homesites because they are above areas affected by floods. Capability unit VIe-5; Sandy Lowland range site; Very Sandy windbreak suitability group.

Judson Series

The Judson series consists of deep, well-drained soils on foot slopes, on fans along bottom lands, and in upland drainageways. These soils formed in colluvial-alluvial material. The material on foot slopes is washed from the adjacent uplands.

In a representative profile the surface layer is very dark brown silt loam about 26 inches thick. The subsoil is very dark gray silt loam 11 inches thick. The underlying material, to a depth of 60 inches, is dark-brown silty clay loam.

Permeability is moderate, and available water capacity is high. The soils are slightly acid. Moisture is released

readily to plants. In some areas occasional flooding can damage crops during heavy rains.

Judson soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Judson silt loam in a cultivated field 1,320 feet west and 50 feet south of the northeast corner of sec. 33, T. 16 N., R. 11 E.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; weak, fine, granular structure; slightly hard, friable; slightly acid; abrupt, smooth boundary.

A12—7 to 26 inches, very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; moderate, medium and fine, subangular blocky structure; slightly hard, friable; slightly acid; clear, wavy boundary.

B—26 to 37 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak, very fine, subangular blocky structure; slightly hard, friable; slightly acid; clear, wavy boundary.

C—37 to 60 inches, dark-brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; few, fine, yellowish-brown (10YR 5/4) mottles; massive; slightly hard, friable; slightly acid.

The A horizon ranges from 18 to 40 inches in thickness. In some places, the soils have a weak to moderately well developed B horizon. The C horizon ranges from silt loam to silty clay loam. Buried soils are in some areas.

Judson soils are near Colo, Kennebec, and Gibbon soils on bottom lands and near Marshall, Monona, and Ponca soils on uplands. In contrast with Colo and Gibbon soils, they are on foot slopes and fans and lack the high water table typical of those soils. They formed in less stratified material than Kennebec soils. They have a thicker A horizon and lack the more strongly expressed B horizon of Marshall, Monona, and Ponca soils.

Judson silt loam, 3 to 7 percent slopes (JuB).—This soil is on colluvial foot slopes in upland drainageways, at the base of slopes, and above the bottom lands. Areas range from 10 to 50 acres in size.

Included with this soil in mapping were small areas of Marshall silty clay loam, 3 to 7 percent slopes; Monona silt loam, 3 to 7 percent slopes; and Colo and Kennebec soils. Also included were urban areas. The degree of reliability of the map decreases as the density of the buildings increases.

This soil is among the most productive in the survey area. It is easy to till, and runoff is medium. Water erosion is the main hazard. Areas along drainageways are subject to gully erosion, and large fans are subject to occasional flooding during heavy rains. Organic-matter content is high.

Most of the acreage is in cultivated crops, mainly corn, soybeans, alfalfa, and wheat. Small acreages are in grain sorghum. Capability unit IIe-1; Silty range site; Silty to Clayey windbreak suitability group.

Kennebec Series

The Kennebec series consists of deep, nearly level, well-drained soils in narrow stream valleys. These soils formed through the slow accumulation of silty alluvium. They are occasionally flooded.

In a representative profile the surface layer is 26 inches thick. The upper part is very dark brown light silty clay loam, the middle part is very dark brown silt loam, and the lower part is very dark gray silt loam. The transitional layer is very dark gray silt loam. The underlying material is dark-gray silt loam to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. The soils are slightly acid. Moisture is released readily to plants.

Kennebec soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Kennebec silt loam in an area of Colo and Kennebec soils, in a cultivated field 0.2 mile north and 0.45 mile east of the southwest corner of sec. 24, T. 16 N., R. 11 E.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) light silty clay loam, dark gray (10YR 4/1) dry; moderate, medium and fine, granular structure; slightly hard, very friable; slightly acid; abrupt, smooth boundary.

A12—7 to 17 inches, very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; strong, medium and fine, subangular blocky structure parting to weak, fine, granular; slightly hard, very friable; slightly acid; clear, wavy boundary.

A13—17 to 26 inches, very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; strong, medium and fine, subangular blocky structure; slightly hard, very friable; slightly acid; clear, wavy boundary.

AC—26 to 42 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate, medium and fine, subangular blocky structure; slightly hard, very friable; slightly acid; clear, wavy boundary.

C—42 to 60 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 5/1) dry; massive, slightly hard, very friable; slightly acid.

The A horizon is light silty clay loam or silt loam. It ranges from 18 to 40 inches in thickness. Some areas have light-colored, stratified material above a depth of 20 inches.

Kennebec soils are near Judson and Colo soils. They are older and developed in more stratified material than Judson soils and lack the B horizon of those soils. They are not so fine textured in the AC horizon as Colo soils.

Kennebec silt loam, occasionally flooded (0 to 1 percent slopes) (Ke).—This soil is on bottom lands in narrow stream valleys. Areas range from 10 to 300 acres in size.

Included with this soil in mapping were areas of Judson silt loam, 3 to 7 percent slopes.

This soil is among the most productive in the survey area. It is easy to till, stores moisture well, and has slow runoff. Occasional flooding is the main hazard. Flooding commonly occurs during periods of heavy rainfall, generally in spring. Organic-matter content is high.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum and wheat. Capability unit IIw-3; Silty Overflow range site; Moderately Wet windbreak suitability group.

Lex Series, Noncalcareous Variant

Lex series, noncalcareous variant, consists of somewhat poorly drained soils that are moderately deep over mixed coarse sand and gravel. These soils are nearly level and are on bottom lands in the Platte and Elkhorn River Valleys. The water table is at depths between 2 and 6 feet.

In a representative profile the surface layer is very dark brown silt loam about 15 inches thick. The transitional layer is grayish-brown silt loam 6 inches thick. The underlying material extends to a depth of 60 inches. It is light

brownish-gray very fine sandy loam in the upper 7 inches. Below this is grayish-brown mixed coarse sand and gravel.

Permeability is moderate in the upper part of the soil and very rapid in the sand and gravel layer. Available water capacity is moderate. The soils are mildly alkaline. Moisture is released readily to plants.

These soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Lex silt loam, noncalcareous variant, in a cultivated field 0.3 mile south and 0.3 mile east of the northwest corner of sec. 15, T. 16 N., R. 9 E.

Ap—0 to 6 inches, very dark brown (10YR 2/2) silt loam, gray (10YR 5/1) dry; weak, fine, granular structure; hard, very friable; mildly alkaline; abrupt, smooth boundary.

A12—6 to 15 inches, very dark brown (10YR 2/2) silt loam, gray (10YR 5/1) dry; weak, medium, subangular blocky structure parting to weak, fine, granular; hard, very friable; mildly alkaline; clear, wavy boundary.

AC—15 to 21 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; weak, medium and coarse, subangular blocky structure parting to weak, fine, subangular blocky; hard, very friable; mildly alkaline; abrupt, smooth boundary.

C1—21 to 28 inches, light brownish-gray (10YR 6/2) very fine sandy loam, light gray (10YR 7/2) dry; few, common, distinct, yellowish-brown (10YR 5/4) mottles; massive; very friable; mildly alkaline; abrupt, smooth boundary.

IIC2—28 to 60 inches, grayish-brown (10YR 5/2) mixed coarse sand and gravel, light gray (10YR 7/2) dry; single grained; loose; neutral.

The A horizon ranges from 7 to 15 inches in thickness. The depth to coarse sand and gravel ranges from 20 to 40 inches.

The Lex soils in this survey area are not calcareous, and therefore are outside the defined range of characteristics for the Lex series. They are recognized as a noncalcareous variant.

Lex soils are near Alda, Gibbon, Platte, and Wann soils. They have a medium-textured AC horizon, whereas Alda soils have a moderately coarse textured AC horizon. The Lex soils in this survey area lack the lime that is typical of Alda soils. They are moderately deep over sand and gravel, whereas Gibbon and Wann soils are deep. They are less shallow than Platte soils.

Lex soils, noncalcareous variant (0 to 1 percent slopes) (Le).—This unit is on bottom lands in the Platte and Elkhorn River Valleys. Areas range from 5 to 50 acres in size. The surface layer ranges from silt loam to silty clay.

Included with this unit in mapping were small areas of Alda very fine sandy loam, Gibbon silt loam, and Alda fine sandy loam.

Wetness is the main hazard in cultivated areas. Runoff is slow. Late in winter and in spring, the water table is at its highest level, 24 to 36 inches below the surface. Tillage is delayed, and the soil is slow to warm. In summer the water table drops to a depth of 60 inches or more, and the soil is droughty. Root growth is inhibited by the mixed coarse sand and gravel layer. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly corn and soybeans. Small amounts of grain sorghum, wheat, and alfalfa are grown. Capability unit IIIw-4; Subirrigated range site; Moderately Wet windbreak suitability group.

Luton Series

The Luton series consists of deep, nearly level, poorly drained soils on bottom lands in the Platte and Elkhorn River Valleys. These soils formed in clayey alluvial sediment. Depth to the water table ranges from 3 to 8 feet.

In a representative profile the surface layer is silty clay about 17 inches thick. The upper part is black, the middle part is very dark gray, and the lower part is dark gray. The subsoil is gray, very sticky silty clay about 10 inches thick. The underlying material is silty clay. It is dark gray in the upper 9 inches and mottled gray in the lower part.

Permeability is very slow, and surface drainage is poor. Available water capacity is moderate. The soils are neutral above a depth of 10 inches and moderately alkaline beneath this depth. Moisture is released slowly to plants.

Luton soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Luton silty clay in a cultivated field 0.45 mile south and 0.2 mile east of the northwest corner of sec. 6, T. 16 N., R. 10 E.:

Ap—0 to 6 inches, black (10YR 2/1) silty clay, black (10YR 2/1) dry; weak, fine, granular structure; hard, very sticky; neutral; abrupt, smooth boundary.

A12—6 to 10 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) dry; weak, coarse, prismatic structure parting to moderate, medium and fine, blocky; hard, very sticky; neutral; clear, wavy boundary.

A3—10 to 17 inches, dark-gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; weak, coarse, prismatic structure parting to strong, medium and fine, blocky; hard, very sticky; mildly alkaline; abrupt, smooth boundary.

B—17 to 27 inches, gray (10YR 5/1) silty clay, light brownish gray (10YR 6/2) dry; weak, coarse, prismatic structure parting to moderate, medium and fine, blocky; hard, very sticky; violent effervescence; moderately alkaline; clear, wavy boundary.

C1—27 to 36 inches, dark-gray (10YR 4/1) silty clay, dark gray (10YR 4/1) dry; massive; hard, very sticky; violent effervescence; moderately alkaline; clear, wavy boundary.

C2—36 to 60 inches, gray (10YR 5/1) silty clay, light brownish gray (10YR 6/2) dry; many, fine, distinct, yellowish-brown (10YR 5/4) mottles; massive; hard, very sticky; violent effervescence; moderately alkaline.

The A horizon is silty clay, silty clay loam, or silt loam. It ranges from 10 to 20 inches in thickness.

Luton soils are near Wabash and Gibbon soils. They are calcareous, whereas Wabash soils are noncalcareous. They are finer textured below the A horizon than Gibbon soils.

Luton silty clay (0 to 1 percent slopes) (Lu).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. In places it is in old abandoned channels of the rivers. These areas are on the lower part of the landscape. This soil has the profile described as representative of the series. Areas range from 10 to 200 acres in size.

Included with this soil in mapping were a few areas of Wabash silty clay, Luton silt loam, Luton silty clay loam, and Gibbon-Slickspots complex.

Wetness is the main hazard if this soil is cultivated. Surface drainage is the main concern in management. Runoff is very slow. Water stands in depressions and low areas for several days after rains, and this delays tillage. This soil is slow to warm in spring. Most areas are plowed in fall. If snow cover or other protection is inadequate, soil blowing is a minor hazard in winter. Organic-matter content is moderate. This soil is difficult to till because it is very sticky when wet and hard when dry.

Most of the acreage is in cultivated crops, mainly wheat, corn, and soybeans. Small acreages are in grain sorghum and alfalfa. Capability unit IIIw-1; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Luton silt loam, overwash (0 to 1 percent slopes) (Ls).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. It is generally close to an old stream channel. This soil has a profile similar to that described as representative of the series, but the surface layer is 10 to 20 inches of silt loam alluvium. Areas range from 10 to 50 acres in size.

Included with this soil in mapping were a few areas of Luton silty clay loam and Gibbon silty clay loam.

This soil is easier to till and the surface layer dries more quickly than Luton soils, which have a silty clay surface layer. Runoff is slow. During periods of heavy rainfall, the very slow permeability of the underlying material causes the surface layer to remain wet for long periods of time. This delays tillage. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly wheat, corn, and soybeans. Small acreages are in grain sorghum and alfalfa. Capability unit IIIw-2; Silty Overflow range site; Moderately Wet windbreak suitability group.

Luton silty clay loam (0 to 1 percent slopes) (Lt).—This soil is on bottom lands in the Platte and Elkhorn River Valleys. This soil has a profile similar to that described as representative of the series, but the surface layer is 10 to 20 inches of silty clay loam. Areas range from 10 to 80 acres in size.

Included with this soil in mapping were a few areas of Luton silty clay and Luton silt loam, overwash.

Wetness is the main hazard if this soil is cultivated. Runoff is very slow. Surface drainage is a concern in management. Water stands in low areas for several days after a heavy rain, and this delays tillage. This soil is slow to warm in spring. Most areas are plowed in fall. Organic-matter content is moderate. The soil is hard to till.

Most of the acreage is in cultivated crops, mainly wheat, corn, and soybeans. Small acreages are in grain sorghum and alfalfa. Capability unit IIIw-1; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Marshall Series

The Marshall series consists of deep, well-drained, nearly level to moderately steep soils on uplands. These soils formed in loess.

In a representative profile the surface layer is silty clay loam about 16 inches thick. The upper part is very dark brown, and the lower part is very dark grayish brown. The subsoil is friable silty clay loam about 23 inches thick. The upper 5 inches is dark brown, the middle 6 inches is dark yellowish brown, and the rest is yellowish brown. The underlying material is light yellowish-brown silty clay loam that reaches to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. The surface layer is medium acid. Moisture is released readily to plants.

Marshall soils are suited to cultivated crops. They are also suited to grass and to plantings for windbreaks. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Marshall silty clay loam, 0 to 1 percent slopes, in a cultivated field 1,320 feet north and 100 feet east of the southwest corner of sec. 6, T. 15 N., R. 11 E.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) silty clay loam, grayish brown (10YR 5/2) dry; weak, fine, granular structure; hard, friable; medium acid; abrupt, smooth boundary.

A12—7 to 16 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak, medium, prismatic structure parting to weak, fine, subangular blocky; hard, friable; medium acid; abrupt, smooth boundary.

B21—16 to 21 inches, dark-brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate, coarse, prismatic structure parting to weak, medium and fine, blocky; hard, friable; medium acid; clear, wavy boundary.

B22—21 to 27 inches, dark yellowish-brown (10YR 4/4) silty clay loam, brown (10YR 5/3) dry; moderate, coarse, prismatic structure parting to moderate, coarse and medium, blocky; hard, friable; slightly acid; clear, wavy boundary.

B3—27 to 39 inches, yellowish-brown (10YR 5/4) silty clay loam, pale brown (10YR 6/3) dry; common, fine, distinct, yellowish-brown (10YR 5/4) mottles; weak, coarse, prismatic structure parting to massive; hard, friable; slightly acid; clear, wavy boundary.

C—39 to 60 inches, light yellowish-brown (10YR 6/4) silty clay loam, pale brown (10YR 6/3) dry; common, medium, distinct, yellowish-brown (10YR 5/4) mottles; massive; hard, friable; neutral.

The A horizon ranges from 8 to 20 inches in thickness. It ranges from very dark brown to black and grades to very dark grayish brown in the lower part. These soils are typically free of carbonates to a depth of 60 inches or more.

In mapping units MaC2, MeD2, and MfE2, the A horizon is lighter colored and thinner than is defined as the range for the Marshall series, but this difference does not alter the usefulness or behavior of these soils.

Marshall soils are near Ida, Judson, Monona, and Ponca soils. They have a B horizon that is lacking in Ida soils. They have a thinner A horizon than Judson soils. They have a finer textured B horizon than Monona soils. They are lower in content of lime than Ponca soils.

Marshall silty clay loam, 0 to 1 percent slopes (MaA).—This silty soil is on the loess-covered uplands. It has the profile described as representative of the series. Areas range from 20 to 1,000 acres in size.

Included with this soil in mapping were small areas of Marshall silty clay loam, 1 to 3 percent slopes, and areas where the surface layer is thicker than is typical.

This is a productive soil, except during years of below normal rainfall. It is easy to till, has slow runoff, and is little affected by water erosion and soil blowing. Organic-matter content is moderate. Lime is needed for legumes.

The entire acreage is in cultivated crops, mainly corn, soybeans, and alfalfa (fig. 5). Small acreages are in grain sorghum and wheat. Capability unit I-1; Silty range site; Silty to Clayey windbreak suitability group.

Marshall silty clay loam, 1 to 3 percent slopes (MaB).—This deep, silty soil is on ridgetops of the uplands. It has a profile similar to the one described as representative of the series, but the surface layer is slightly thinner. Areas range from 10 to 100 acres in size.

Included with this soil in mapping were a few small areas where the soil is moderately eroded and small areas of Marshall silty clay loam, 0 to 1 percent slopes.

Water erosion is the main hazard. Runoff is medium. Organic-matter content is moderate. The soil is easy to till.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum

Figure 5.—**Corn and soybeans on Marshall silty clay loam, 0 to 1 percent slopes.**

and wheat. Capability unit IIe-1; Silty range site; Silty to Clayey windbreak suitability group.

Marshall silty clay loam, 3 to 7 percent slopes (MaC).—This deep, silty soil is on broad ridgetops of the uplands. It has a profile similar to the one described as representative of the series, but the surface layer is slightly thinner. Areas range from 5 to 40 acres in size.

Included with this soil in mapping were a few small areas of Marshall silty clay loam, 3 to 7 percent slopes, eroded. Also included were urban areas, where the degree of reliability of the map decreases as the density of the buildings increases.

Water erosion is a moderate hazard in cultivated areas. Some rills and gullies form, but are plowed under by each successive tillage. Runoff is medium. Organic-matter content is moderate. This soil is easy to till.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum and wheat. Some areas are used for urban construction. Capability unit IIe-1; Silty range site; Silty to Clayey windbreak suitability group.

Marshall silty clay loam, 3 to 7 percent slopes, eroded (MaC2).—This deep silty soil is on narrow ridgetops of the uplands. It has a profile similar to the one described as representative of the series, but the surface layer is lighter colored and slightly thinner (fig. 6). Areas range from 5 to 20 acres in size.

Included with this soil in mapping were a few small areas of Marshall silty clay loam, 3 to 7 percent slopes.

Water erosion is the main hazard in cultivated areas. Small rills are common. Runoff is medium. Organic-matter content is lower than in uneroded areas of Marshall soils. The soil is easy to till.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in wheat and grain sorghum. Capability unit IIIe-8; Silty range site; Silty to Clayey windbreak suitability group.

Marshall silty clay loam, 7 to 11 percent slopes (MaD).—This deep silty soil is commonly on the lower hillsides or is adjacent to and in the upper ends of drainageways. It has a profile similar to the one described as representative of the series, but the surface layer is only 6 to 8 inches thick. Areas range from 5 to 30 acres in size.

Included with this soil in mapping were a few small areas of Marshall-Ponca silty clay loams, 7 to 11 percent slopes, eroded. Also included were urban areas, where the degree of reliability of the map decreases as the density of the buildings increases.

Water erosion is the main hazard in cultivated areas. Runoff is medium to rapid. Conserving rainfall is the main concern in management. Organic-matter content is moderate. The soil is easy to till.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum and wheat. Some inaccessible areas are in bromegrass. Some areas are used for urban development. Capability unit IIIe-1; Silty range site; Silty to Clayey windbreak suitability group.

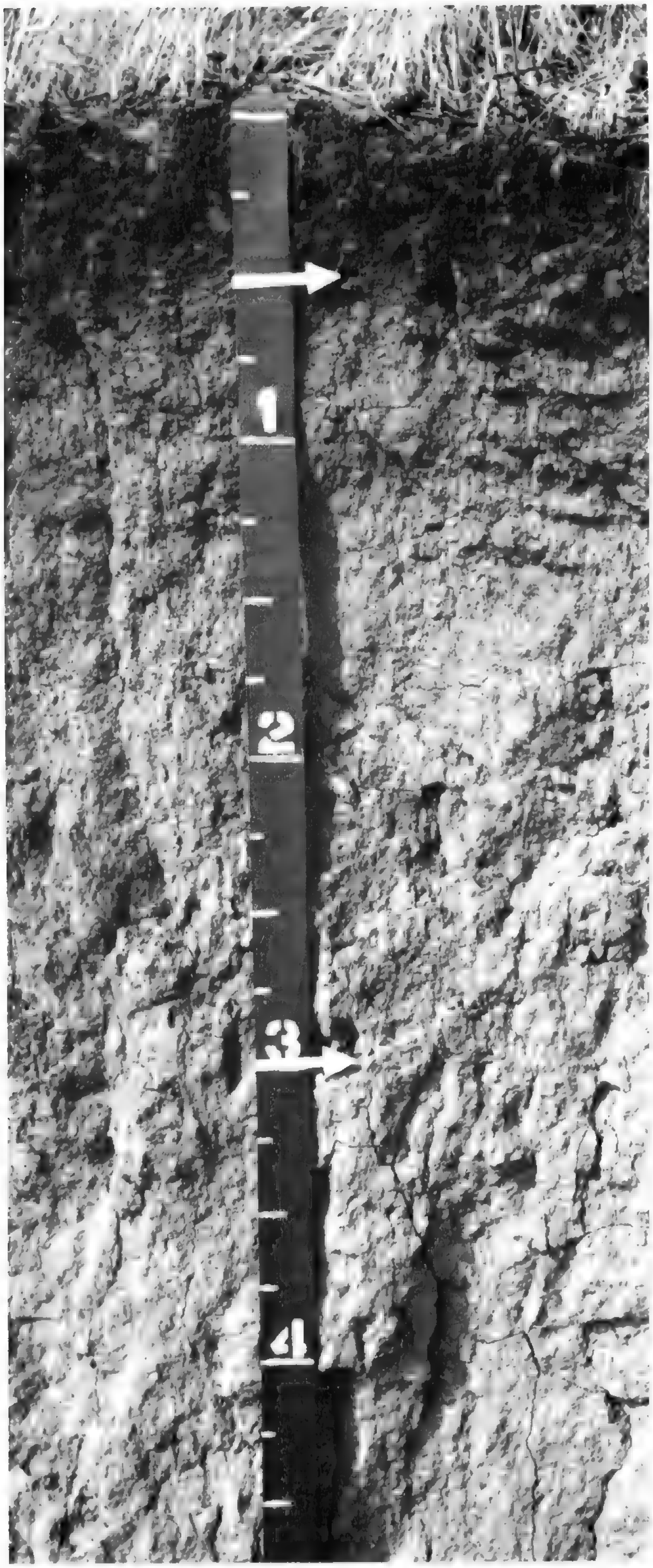


Figure 6.—**Profile of Marshall silty clay loam, eroded. The surface layer is about 6 inches thick.**

Marshall-Ponca silty clay loams, 7 to 11 percent slopes, eroded (MeD2).—This complex of soils is above the moderately steep areas that border entrenched drainageways in the uplands. Slopes are smooth. About 70 percent of the acreage is Marshall silty clay loam, and 30 percent is Ponca silty clay loam. Areas range from 20 to 1,000 acres in size.

Each soil has a profile similar to the one described as representative of its respective series, but the surface layer is thinner and lighter colored. Water erosion has removed most of the original surface layer from these soils. The present surface layer is dark yellowish brown and in places is mixed with material from the subsoil. These areas are low in organic-matter content and lack the fertility of soils that are not so eroded.

Included with these soils in mapping were a few small areas of glacial till, Dakota Sandstone, and Loveland Loess. These areas are shown by special symbols on the detailed soil map.

Water erosion is the main hazard in cultivated areas. Runoff is rapid. Conserving rainfall is the main concern in management. Organic-matter content is moderate to moderately low. The soils are easy to till.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Smaller acreages are in grain sorghum and wheat. Small areas are in bromegrass. Capability unit IIIe–8; Silty range site; Silty to Clayey windbreak suitability group.

Marshall and Ponca soils, 11 to 17 percent slopes (MfE).—These soils are adjacent to entrenched drainageways in the uplands. Some areas are entirely Marshall soils, others are entirely Ponca soils, and many contain both soils. Areas range from 10 to 60 acres in size.

Each soil has a profile similar to the one described as representative of its respective series, but the surface layer is thinner. Texture of the surface layer is silt loam or silty clay loam.

Included with these soils in mapping were a few small areas of glacial till, Loveland Loess, and Dakota Sandstone. These areas are shown by special symbols on the detailed soil map. Also included were urban areas where the degree of reliability of the map decreases as the density of the buildings increases.

Water erosion is the main hazard. Runoff is rapid. Conserving rainfall is the main concern in management. Organic-matter content is moderate. The soils are easy to till.

Most of the acreage is in native grass. Small acreages are in cultivated crops, mainly corn, alfalfa, and soybeans. Smaller acreages are in grain sorghum and wheat. Erosion is moderate in the areas that have been cultivated on the contour. Some areas are used for urban development. Capability unit IVe–1; Silty range site; Silty to Clayey windbreak suitability group.

Marshall and Ponca soils, 11 to 17 percent slopes, eroded (MfE2).—These soils are on the sides of entrenched drainageways in the uplands. Some areas are entirely Marshall soils, others are entirely Ponca soils, and many contain both soils. Areas range from 10 to 100 acres in size.

Each soil has a profile similar to the one described as representative of its respective series, but the surface layer is thinner and lighter colored. The texture of the surface layer is silt loam or silty clay loam. Water erosion has removed most of the original surface layer from this soil. In places material from the subsoil is mixed with the pres-

ent surface layer. These areas are low in organic-matter content and lack the fertility of soils that are not so eroded.

Included with these soils in mapping were a few small areas of glacial till, Loveland Loess, and Dakota Sandstone. These areas are indicated by special symbols on the detailed soil map.

Water erosion is the main hazard. Runoff is rapid. Small gullies are common. Conserving rainfall is the main concern in management. Organic-matter content is moderate to moderately low.

Most areas are in cultivated crops, mainly corn and alfalfa. Small acreages are in grain sorghum, wheat, and soybeans. Some areas are in bromegrass. Capability unit IVe–8; Silty range site; Silty to Clayey windbreak suitability group.

Monona Series

The Monona series consists of deep, well-drained, nearly level to very steep soils that formed in loess. This material ranges from 30 to 50 feet in thickness.

In a representative profile the surface layer is very dark grayish-brown silt loam about 10 inches thick (fig. 7). The subsoil is very friable silt loam about 23 inches thick. The upper part is dark brown, and the middle and lower parts are yellowish brown. The underlying material, at a depth of 33 inches, is yellowish-brown silt loam.

Permeability is moderate, and available water capacity is high. The surface layer is slightly acid. Moisture is released readily to plants.

Monona soils are generally suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Monona silt loam, 1 to 3 percent slopes, in a cultivated field 1,056 feet east and 50 feet south of the northwest corner of sec. 8, T. 16 N., R. 12 E.:

Ap 0 to 5 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, fine, granular structure; slightly hard, very friable; slightly acid; abrupt, smooth boundary.

A12 5 to 10 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; slightly hard, friable; slightly acid; abrupt, smooth boundary.

B21—10 to 14 inches, dark-brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; moderate, coarse, prismatic structure parting to medium and fine subangular blocky; slightly hard, very friable; neutral; clear, wavy boundary.

B22—14 to 21 inches, yellowish-brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate, medium and coarse, prismatic structure parting to moderate, medium and fine, subangular blocky; slightly hard, very friable; neutral; clear, wavy boundary.

B3—21 to 33 inches, yellowish-brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; weak, coarse, prismatic structure parting to massive; slightly hard, very friable; neutral; clear, wavy boundary.

C—33 to 60 inches, yellowish-brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; many, fine, reddish-brown (5YR 4/3) mottles; massive; slightly hard, very friable; mildly alkaline.

The A horizon ranges from 7 to 18 inches in thickness. Carbonates are commonly at a depth of about 4 feet, but range from extremes of 2 to 6 feet.

In mapping units MoC2, MoD2, MsE2, and MsF2, the A horizon is lighter colored and thinner than is defined as the

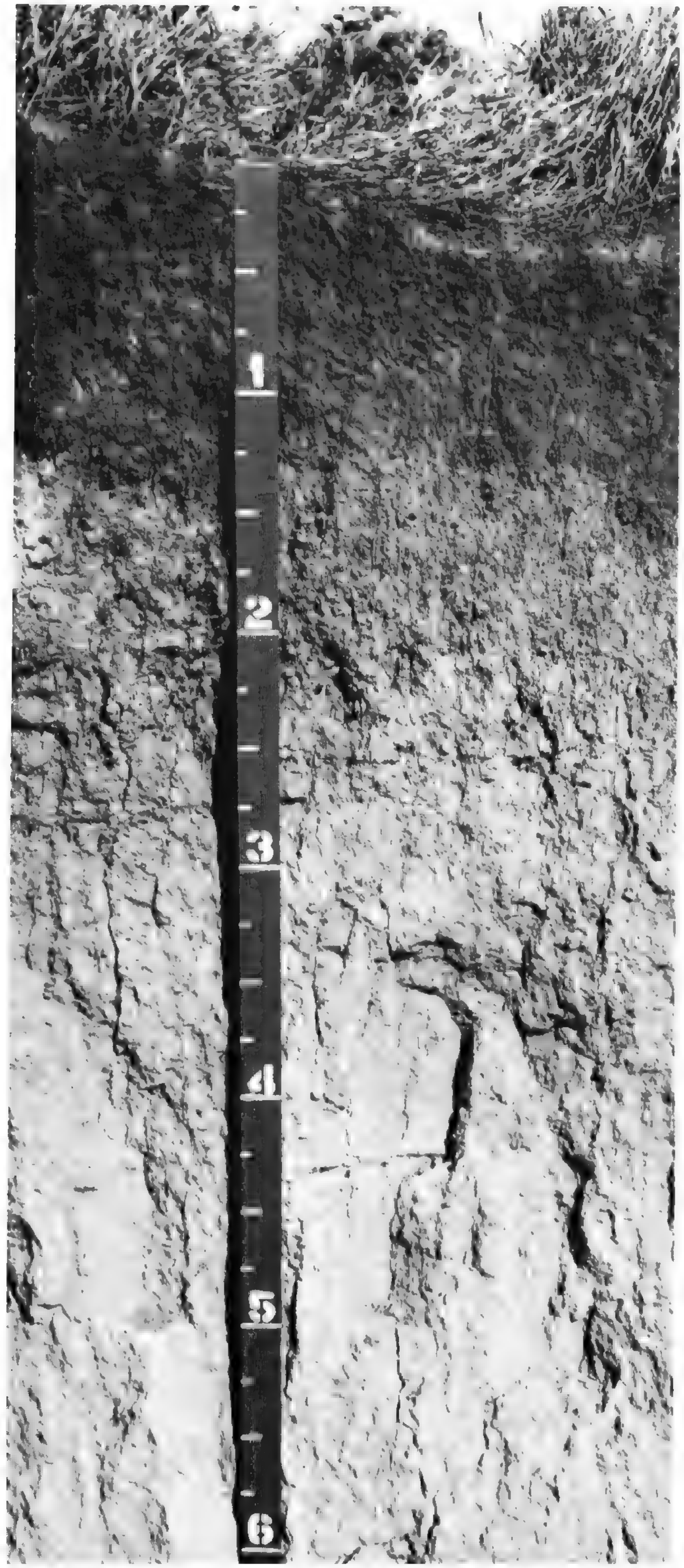


Figure 7.—**Profile of Monona silt loam showing thick surface layer and lime at a depth of about 46 inches.**

range for the Monona series. This difference does not alter the usefulness or behavior of the soils.

Monona soils are near Ida, Judson, and Marshall soils. They have a thicker A horizon than Ida soils and have a B horizon that those soils lack. They have a thinner A horizon and a lighter colored B horizon than Judson soils. They have less clay in the B horizon than Marshall soils.

Monona silt loam, 0 to 1 percent slopes (MoA).—This silty soil is on loess uplands. It has a profile similar to that described as representative of the series, but the surface layer is thicker. Areas range from 10 to 80 acres in size.

Included with this soil in mapping were a few small areas of Monona silt loam, 1 to 3 percent slopes, and areas where the surface layer is very dark grayish brown to a depth of 30 inches. Also included were urban areas, where the degree of reliability of the map decreases as the density of the buildings increases.

This soil is easy to till. It is not appreciably affected by soil blowing or water erosion. Runoff is medium. Lime is needed for legumes.

This soil is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum and wheat. Many areas are used for suburban homesites. Capability unit I–1; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 1 to 3 percent slopes (MoB).—This deep, silty soil is on uplands. It has the profile described as representative of the series. Areas range from 10 to 100 acres in size.

Included with this soil in mapping were a few small areas of Monona silt loam, 0 to 1 percent slopes.

This soil is easy to till. Water erosion is the main hazard. Runoff is medium. Organic-matter content is moderate. Lime is needed for legumes.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum and wheat. Capability unit IIe–1; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 3 to 7 percent slopes (MoC).—This deep, silty soil is on broad upland ridgetops. It has a profile similar to that described as representative of the series, but the surface layer is slightly thinner. Areas range from 5 to 40 acres in size.

Included with this soil in mapping were a few small areas of Monona silt loam, 1 to 3 percent slopes, and Monona silt loam, 3 to 7 percent slopes, eroded. Also included were urban areas, where the degree of reliability of the map decreases as the density of the buildings increases.

This soil is easy to till. Water erosion is the main hazard. Runoff is medium. Some rills and gullies form, but they are plowed in with each successive tillage. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum and wheat. Some areas are used for suburban homesites and industrial sites. Capability unit IIe–1; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 3 to 7 percent slopes, eroded (MoC2).—This deep, silty soil is on narrow upland ridgetops. It has a profile similar to that described as representative of the series, but the surface layer is lighter colored and is slightly thinner. Areas range from 5 to 20 acres in size.

Included with this soil in mapping were a few small areas of Monona silt loam, 3 to 7 percent slopes.

This soil is easy to till. Water erosion is the main hazard. Runoff is medium. Some rills and gullies are common. Organic-matter content is less than in the uneroded areas of Monona soils.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in wheat and grain sorghum. Capability unit IIIe–8; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 7 to 11 percent slopes (MoD).—This deep, silty soil is on the lower parts of hillsides. It also is adjacent to and in the upper end of drainageways. It has a profile similar to that described as representative of the series, but the surface layer is slightly thinner. Areas range from 5 to 35 acres in size.

Included with this soil in mapping were a few small areas of Monona silt loam, 7 to 11 percent slopes, eroded. Also included were urban areas, where the degree of reliability of the map decreases as the density of the buildings increases.

This soil is easy to till. Runoff is medium. Water erosion is the main hazard. Conserving rainfall is the main concern in management. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum and wheat. Some inaccessible areas are in bromegrass. Some areas are used for suburban developments. Capability unit IIIe–1; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 7 to 11 percent slopes, eroded (MoD2).—This soil is in smooth areas above steeper soils that border entrenched drainageways in the uplands. This soil has a profile similar to that described as representative of the series, but the surface layer is thinner and lighter colored. Areas range from 20 to 500 acres in size.

Included with this soil in mapping were a few small areas of Ida silt loam, 7 to 17 percent slopes, eroded. Small outcrops of glacial till and Dakota Sandstone are shown on the detailed map by special symbols.

This soil is easy to till. Runoff is medium. Water erosion is the main hazard. Conserving rainfall is the main concern in management. Organic-matter content is moderate to moderately low.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum and wheat. Some areas are in bromegrass. Capability unit IIIe–8; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 11 to 17 percent slopes (MoE).—This soil is adjacent to entrenched drainageways in the uplands. This soil has a profile similar to that described as representative of the series, but the surface layer is slightly thinner. Areas range from 10 to 50 acres in size.

Included with this soil in mapping were a few small areas of Monona silt loam, 7 to 11 percent slopes, Monona silt loam, 11 to 17 percent slopes, eroded, and Ida silt loam, 7 to 17 percent slopes, eroded. Also included were urban areas, where the degree of reliability of the map decreases as the density of the buildings increases.

This soil is easy to till. Runoff is medium. Water erosion is the main hazard. Conserving rainfall is the main concern in management. Organic-matter content is moderate.

Most of the acreage is in grass or has been contour farmed, so the degree of erosion is only moderate. Small areas are in cultivated crops, mainly corn, alfalfa, and grain sorghum. Small acreages are in soybeans and wheat. Some areas are used for urban developments. Capability unit IVe–1; Silty range site; Silty to Clayey windbreak suitability group.

Monona and Ida silt loams, 11 to 17 percent slopes, eroded (MsE2).—These soils are adjacent to entrenched drainageways in the uplands. Some areas are entirely Monona silt loam, others are entirely Ida silt loam, and many contain both soils. The areas range from 10 to 100 acres in size.

Each soil has a profile similar to the one described as representative of its respective series, but the surface layer is thinner.

Included with these soils in mapping were a few small areas of Monona and Ida silt loams, 17 to 30 percent slopes, eroded.

Runoff is medium to rapid. Water erosion is the main hazard. Conserving and holding rainfall are the main concerns in management. Organic-matter content is moderate to low.

Most of the acreage is in cultivated crops, mainly corn and alfalfa. Small acreages are in grain sorghum, wheat, and soybeans. Some areas are in bromegrass. Capability unit IVe–8; Silty to Clayey windbreak suitability group; Monona soil in Silty range site, Ida soil in Limy Upland range site.

Monona and Ida silt loams, 17 to 30 percent slopes (MsF).—These steep soils are mainly under grass and trees. Some areas are entirely Monona silt loam, others are entirely Ida silt loam, and many contain both soils. Areas range from 10 to 100 acres in size.

Each soil has a profile similar to the one described as representative of its respective series, but the surface layer is slightly thinner.

Included with these soils in mapping were a few small areas of Loveland Loess and glacial till that are shown by special symbols on the detailed soil map. Also included were small areas of Rough broken land, loess.

Runoff is medium to rapid. Water erosion is the main hazard. Conserving and holding rainfall are the main concerns in management. Organic-matter content is moderate to low.

Most of the acreage is in grass or grass and trees. The main grasses are big bluestem, little bluestem, side-oats grama, and switchgrass. Oaks, elm, and hackberry are the main trees. Capability unit VIe–1; Undesirable windbreak suitability group; Monona soil in Silty range site, Ida soil in Limy Upland range site.

Monona and Ida silt loams, 17 to 30 percent slopes, eroded (MsF2).—These soils have been cleared of trees and brush and have been cultivated in the past. Some areas of this mapping unit are entirely Monona silt loam, others are entirely Ida silt loam, and many contain both soils. Areas range from 10 to 50 acres in size.

Each soil has a profile similar to the one described as representative of its respective series, but the surface layer is thinner.

Included with these soils in mapping were a few small areas of Loveland Loess and glacial till that are shown by special symbols on the detailed soil map. Also included were some areas of Rough broken land, loess.

Runoff is rapid. Water erosion is the main hazard. Organic-matter content is moderate to low.

These soils are too steep for cultivated crops. Most areas should be returned to grass. Areas that are in abandoned orchards, vineyards, or truck gardens should be revegetated. Big bluestem, little bluestem, indiangrass, side-oats grama, and switchgrass are better suited than other grasses. Capability unit VIe–8; Undesirable windbreak suitability group; Monona soil in Silty range site, Ida soil in Limy Upland range site.

Monona and Ida silt loams, 30 to 60 percent slopes (MsG).—These soils are on breaks in the Missouri and Platte River Valleys. Areas are mostly in mixed stands of trees and grass. Fontenelle Forest is included. Some areas are entirely Monona silt loam, others are entirely Ida silt loam, and many contain both soils. Areas range from 20 to 400 acres in size.

Each soil has a profile similar to the one described as representative of its respective series, but the surface layer is slightly thinner.

Included with these soils in mapping were a few small areas of Loveland Loess and glacial till. These are shown by special symbols on the detailed soil map. Also included were small areas of Gullied land and areas under forest cover that have uncoated sand grains on the structural surface of the upper part of the subsoil.

Runoff is very rapid. Water erosion is the main hazard. Organic-matter content is moderate to low.

These soils are too steep for cultivated crops. Trees, mainly oaks, elms, hackberry, hickory, linden, hawthorne, and redbud, are the dominant cover. Small areas are in native grass, mainly big bluestem, little bluestem, indiangrass, side-oats grama, and switchgrass. Capability unit VIIe–1; Undesirable windbreak suitability group; Monona soil in Silty range site, Ida soil in Limy Upland range site.

Onawa Series

The Onawa series consists of deep, nearly level, somewhat poorly drained, calcareous soils on bottom lands in the Missouri River Valley. These soils formed in alluvium of recently deposited clayey material underlain by silty material. Depth to the water table ranges from 3 to 8 feet. The soils are occasionally flooded.

In a representative profile the surface layer is very dark gray silty clay about 7 inches thick. The underlying material extends to a depth of 60 inches. It is dark grayish-brown silty clay in the upper part; dark grayish-brown silt loam in the middle part; and dark grayish-brown fine sandy loam in the lower part.

Permeability is slow in the upper part of the soil and moderate in the lower part. Available water capacity is high. The surface layer is mildly alkaline. Moisture is released slowly to plants.

Most Onawa soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Onawa silty clay in a cultivated field 1,056 feet east and 60 feet north of the southwest corner of sec. 7, T. 13 N., R. 14 E.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak, coarse, blocky structure

parting to weak granular; hard, very sticky; strong effervescence; mildly alkaline; abrupt, smooth boundary.

C1g—7 to 18 inches, dark grayish-brown (2.5Y 4/2) silty clay, gray (10YR 5/1) dry; faint olive-brown (2.5Y 4/4) mottles; moderate, coarse, angular blocky structure parting to strong, medium and fine, angular blocky; hard, very sticky; strong effervescence; mildly alkaline; clear, wavy boundary.

IIC2—18 to 50 inches, dark grayish-brown (2.5Y 4/2) silt loam, light gray (10YR 7/1) dry; many, distinct, dark yellowish-brown mottles (10YR 4/4); weak, coarse, blocky structure parting to weak, medium and fine, platy; hard, friable; violent effervescence; moderately alkaline; abrupt, smooth boundary.

IIC3—50 to 60 inches, dark grayish-brown (2.5Y 4/2) fine sandy loam, light gray (10YR 7/2) dry; weak, medium and fine, platy structure parting to single grained; slightly hard, friable; violent effervescence; moderately alkaline.

The A horizon is 6 to 10 inches thick. The profile is silty clay to depths ranging from 16 to 28 inches and is silt loam, very fine sandy loam, or fine sandy loam in the lower part.

Onawa soils are near Albaton, Haynie, and Percival soils. They are fine textured in the upper part, whereas Albaton soils are fine textured throughout the C horizon, Haynie soils are medium textured throughout the profile, and Percival soils have a coarse-textured IIC2 horizon.

Onawa silty clay (0 to 1 percent slopes) (On).—This soil is on moderately low bottom lands in the Missouri River Valley. Areas range in size from 10 to 80 acres.

Included with this soil in mapping were small areas of Albaton silty clay and Percival silty clay.

This soil is hard to till. Runoff is slow. Wetness caused by the high water table and the slow permeability in the upper part of the profile is the main hazard. Tillage is delayed by wetness, and the soil is slow to warm up in spring. Organic-matter content and nitrogen content are both low. Because this soil is high in lime content, the availability of phosphorus is low.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and wheat. Small acreages are in grain sorghum and alfalfa. Capability unit IIw-1; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Percival Series

The Percival series consists of deep, nearly level, somewhat poorly drained soils on bottom lands of the Missouri River Valley. These soils formed in material composed of clayey alluvium in the upper part and sandy alluvium in the lower part. They are commonly protected from flooding by large dams upriver and by dikes along the river banks. The soils are normally calcareous throughout. Depth to the water table ranges from 3 to 8 feet.

In a representative profile the surface layer is very dark gray silty clay about 7 inches thick. The underlying material extends to a depth of 60 inches. It is dark grayish-brown silty clay in the upper 9 inches, dark grayish-brown loamy fine sand in the middle 4 inches, and grayish-brown fine sand in the lower 40 inches.

Permeability is slow in the upper part of the soil and rapid in the lower part. Available water capacity is low. The surface layer is mildly alkaline. Moisture is released slowly to plants.

Percival soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Percival silty clay in a cultivated field 1,584 feet east and 60 feet north of the southwest corner of sec. 7, T. 13 N., R. 14 E.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; weak, coarse, angular blocky structure parting to weak, fine, granular; hard, very sticky; strong effervescence; mildly alkaline; abrupt, smooth boundary.

C1g—7 to 16 inches, dark grayish-brown (2.5Y 4/2) silty clay, light gray (10YR 6/1) dry; many dark yellowish-brown (10YR 4/4) mottles; moderate, coarse, angular blocky structure parting to strong, medium and fine, angular blocky; hard, very sticky; violent effervescence; moderately alkaline; abrupt, smooth boundary.

IIC2—16 to 20 inches, dark grayish-brown (10YR 4/2) loamy fine sand, light gray (10YR 7/1) dry; many dark yellowish-brown (10YR 4/4) mottles; single grained; loose; violent effervescence; moderately alkaline; clear, wavy boundary.

IIC3—20 to 60 inches, grayish-brown (10YR 5/2) fine sand, white (10YR 8/1) dry; single grained; loose.

The A horizon is 6 to 10 inches thick. The IIC horizon is loamy fine sand or fine sand below a depth of 15 to 30 inches.

Percival soils are near Albaton and Onawa soils. They are not so fine textured in the lower part of the C horizon and are not so wet as Albaton soils and are at slightly higher elevations than those soils. They are coarser textured in the lower part of the C horizon than Onawa soils.

Percival silty clay (0 to 1 percent slopes) (Pa).—This soil is on high bottom lands in the Missouri River Valley. Areas range from 10 to 60 acres in size.

Included with this soil in mapping were small areas of Onawa silty clay.

This soil is difficult to till. Runoff is slow. Wetness caused by the high water table and the slow permeability in the upper part of the profile is the main hazard. During years of heavy rainfall, tillage is delayed. This soil is slow to warm up in spring. It tends to be droughty during the peak of the growing season. Organic-matter content is low, indicating that nitrogen content is low. Because this soil is high in lime content, the available phosphorus is low.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and wheat. Small acreages are in grain sorghum. Capability unit IIw-1; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Pits and Dumps

Pits and dumps (0 to 9 percent slopes) (Pb) consists of excavations, filled with water, from which sand, gravel, and overburden are removed. Areas range from 5 to 80 acres in size.

Areas where gravel is still being pumped from water-filled pits are subject to changes made by the pumping. A few private individuals use the lakes for fishing, but most areas are off limits to the general public. In areas where the pumping of gravel has ceased, private individuals have built summer homes and developed recreational areas (fig. 8). Some areas have been purchased by developers who built a small subdivision of permanent homes around the shoreline. Some areas located near towns have been developed into public parks. Both private and public areas are used for fishing, boating, water skiing, rock hunting, swimming, hiking, and picnicking.

The waste material from excavation is commonly a fine white sand that makes ideal beaches for lounging and sun bathing. In some areas that have been developed for parks, part of the sand has been pushed into the lakes to reduce

Figure 8.—Gravel pit used for recreation.

the depth of the water. This causes the increase in depth to be gradual and makes the areas less hazardous for swimming. The lakes range from 40 to 80 feet in depth.

Soil blowing is the main hazard in the sand areas around these pits. Planting native grass and trees helps to control soil blowing. The species selected should be suited to the sandy, droughty conditions and to the low fertility. Organic-matter content ranges from very low to none.

Pits and dumps is not suited to cultivation or grazing until vegetation is established. The better part of the overburden can be leveled and planted to grasses, such as big bluestem, little bluestem, indiangrass, switchgrass, reed canarygrass, and sand lovegrass. Cottonwood trees are commonly planted in the picnic areas. Roads generally are built for accessibility. Capability unit VIIIs–1; Undesirable windbreak suitability group; no range site assigned.

Platte Series

The Platte series consists of nearly level, somewhat poorly drained soils on bottom lands in the Platte River Valley. These soils formed in less than 20 inches of loamy material deposited over coarse sand and gravel. Depth to the water table ranges from 2 to 5 feet.

In a representative profile the surface layer is loam about 12 inches thick. The upper part is very dark gray, and the middle and lower parts are black. The underlying material is grayish-brown coarse sand and gravel to a depth of 60 inches.

Permeability is moderate in the upper part and very rapid in the underlying sand and gravel. Available water capacity is low. Moisture is released readily to plants.

Platte soils are suited to cultivated crops, but their use for this purpose is marginal and good management is needed. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Platte loam, from an area of Platte soils, in a cultivated field 0.25 mile west of the southeast corner of sec. 29, T. 13 N., R. 10 E.:

Ap—0 to 4 inches, very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) dry; weak, fine and very fine, granular structure; slightly hard, very friable; slight effervescence; mildly alkaline; abrupt, smooth boundary.

A12—4 to 9 inches, black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak, medium and fine, subangular blocky structure parting to weak, very fine, granular; slightly hard, friable; neutral; abrupt, smooth boundary.

A13—9 to 12 inches, black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak, fine and very coarse, platy structure parting to weak, very fine, granular; hard, friable; neutral.

IIC—12 to 60 inches, grayish-brown (10YR 5/2) mixed coarse sand and gravel, light gray (10YR 7/2) dry; common, fine to coarse, brown (10YR 5/3) mottles; single grained; loose; neutral.

The A horizon ranges from 5 to 12 inches in thickness. This soil has C1 horizon in places. The depth to the IIC horizon ranges from 10 to 20 inches.

Platte soils are near Alda, Cass, Inavale, Lex, and Wann soils. They are shallower over mixed sand and gravel and have a higher water table than Cass or Inavale soils. They are shallower than the moderately deep Alda and Lex soils or the deep Wann soils.

Platte soils (0 to 1 percent slopes) (Pc).—These soils are in old abandoned river channels and low bottom lands adjacent to the Platte River. Areas range from 10 to 30 acres in size. The surface layer ranges from silty clay to loamy fine sand.

Included with these soils in mapping were small areas of Alda very fine sandy loam and Lex soils, noncalcareous variant.

These soils are easy to till. Runoff is slow. Wetness is the main hazard. Late in winter and early in spring, the water table is at its highest level. Tillage is commonly delayed. During the summer, however, the water table can drop to a depth of 60 inches, and the soil becomes droughty for cultivated crops. Root growth is inhibited by the mixed coarse sand and gravel layer. Organic-matter content is low. Nitrogen content is commonly low.

Most of the acreage is in permanent pasture or native hay. Cultivated crops are mainly grain sorghum, wheat, and corn. Capability unit IVw-4; Subirrigated range site; Moderately Wet windbreak suitability group.

Ponca Series

The Ponca series consists of deep, well-drained, strongly sloping to moderately steep soils on uplands.

In a representative profile the surface layer is very dark grayish-brown silty clay loam about 8 inches thick. The subsoil is friable silty clay loam about 16 inches thick. The upper 2 inches is dark grayish brown, and the next 14 inches is brown. The underlying material, to a depth of 60 inches, is yellowish-brown light silty clay loam that has many yellowish-brown mottles in the upper part.

Permeability is moderate, and available water capacity is high. The surface layer and upper part of the subsoil are neutral. Moisture is released readily to plants.

Ponca soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Ponca silty clay loam, from an area of Marshall and Ponca soils, 11 to 17 percent slopes, in a cultivated field 2,376 feet north and 150 feet west of the southeast corner of sec. 28, T. 16 N., R. 11 E.:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak, fine, granular structure; hard, friable; neutral; abrupt, smooth boundary.

B21—8 to 10 inches, dark grayish-brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2)) dry; weak, medium, prismatic structure parting to weak, medium and fine, subangular blocky; hard, friable; neutral; clear, wavy boundary.

B22—10 to 18 inches, brown (10YR 5/3) silty clay loam, light brownish gray (10YR 6/2) dry; weak, coarse, prismatic structure parting to moderate, medium and fine, subangular blocky; hard, friable; neutral; abrupt, smooth boundary.

B3—18 to 24 inches, brown (10YR 5/3) silty clay loam, light brownish gray (10YR 6/2) dry; few, medium, distinct, reddish-brown (5YR 5/4) mottles; weak, medium, prismatic structure parting to massive; hard, friable; violently effervescent; few large and small lime concretions and several small dark concretions; moderately alkaline; clear, wavy boundary.

C1—24 to 30 inches, yellowish-brown (10YR 5/4) light silty clay loam, pale brown (10YR 6/3) dry; many, medium, distinct, yellowish-brown (10YR 5/4) mottles; massive; hard, friable; few dark concretions; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—30 to 60 inches, yellowish-brown (10YR 5/4) light silty clay loam, pale brown (10YR 6/3) dry; massive; hard, friable; strong effervescence; moderately alkaline.

The A, B, and C horizons range from silt loam to silty clay loam. Depth to carbonates ranges from 14 to 25 inches.

Ponca soils in mapping units MeD2, MfE2, PdD2, and PdE2 have an A horizon that is thinner and lighter colored than is defined as the range for the Ponca series.

Ponca soils are near Marshall, Ida, and Judson soils. They have lime higher in the profile than Marshall soils, but not so high as in Ida soils. They have a B horizon, which Ida soils lack. They have a thinner and lighter colored solum than Judson soils.

Ponca and Ida silt loams, 7 to 11 percent slopes, eroded (PdD2).—These soils are above steeper soils that border entrenched drainageways in the uplands. Slopes are smooth. Areas range from 10 to 50 acres in size. Some areas are entirely Ponca silt loam, others are entirely Ida silt loam, and most areas contain both soils.

The Ponca soil has a profile similar to that described as representative of the series, but the surface layer is thinner. The Ida soil is described under the heading "Ida Series."

Included with these soils in mapping were a few small areas of Ponca and Ida silt loams, 11 to 17 percent slopes, eroded, and deposits of glacial till. Areas of glacial till are indicated by a special symbol on the detailed soil map.

Water erosion has removed most of the original surface layer from these soils. The present surface layer is brown or yellowish brown and in places is mixed with material from the subsoil.

These soils are easy to till. Organic-matter content ranges from moderate to low. Runoff is medium. Water erosion is the main hazard. Conserving rainfall is the main concern in management. Improving fertility is also important.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and alfalfa. Small acreages are in grain sorghum and wheat. Small areas are in bromegrass. Capability unit IIIe-8; Silty to Clayey windbreak suitability group; Ponca soil in Silty range site, Ida soil in Limy Upland range site.

Ponca and Ida silt loams, 11 to 17 percent slopes, eroded (PdE2).—These soils are on the hillsides and the sides of entrenched drainageways in the uplands. Some areas are Ponca silt loam, others are entirely Ida silt loam, and many areas contain both soils. Areas range from 10 to 60 acres in size.

The Ponca soil has a profile similar to that described as representative of the Ponca series, but the surface layer is

thinner and lighter colored. The Ida soil is described under the heading "Ida Series."

Included with these soils in mapping were a few small areas of Ponca and Ida silt loams, 7 to 11 percent slopes, eroded. Also included were outcrops of glacial till. These are indicated by a special symbol on the detailed soil map.

Water erosion has removed nearly all the original surface layer, and the original subsoil or underlying material now are tilled. The present surface layer is yellowish brown, calcareous, and low in organic-matter content and fertility.

These soils are easy to till. Organic-matter content is moderate or low. Runoff is rapid. Water erosion is the main hazard. Conserving rainfall is the main concern in management. Improving fertility and organic-matter content is also important.

Most of the acreage is in cultivated crops, mainly corn, and alfalfa. Small acreages are in grain sorghum, wheat, and soybeans. Small areas are also in bromegrass. Capability unit IVe-8; Silty to Clayey windbreak suitability group; Ponca soil in Silty range site, Ida soil in Limy Upland range site.

Riverwash

Riverwash (0 to 2 percent slopes) (Ra) consists of alluvial material deposited as sand bars and islands within and adjacent to channels of the Platte, Elkhorn, and Missouri Rivers. It is mainly sandy, but in places is stratified with silty and clayey material. It is poorly drained and frequently flooded. Areas of Riverwash are channeled and subject to severe cutting action by water during floods. Areas range from 10 to 40 acres in size.

Some areas adjacent to the river channels have been in place for several years. They are covered by mixed coarse grass, shrubs, willows, and cottonwood trees. The more recent deposits have little vegetation. On the islands is a dense stand of willow and cottonwood trees, shrubs, annual weeds, and common reedgrass. The size and shape of the islands can change with each flood.

Flooding and a high water table are the main hazards, mainly to vegetation and wildlife. Late in summer the water table falls, and then soil blowing and droughtiness are hazards. Organic-matter content and fertility are low.

Riverwash is not suitable for cultivation. It is commonly managed as range and used for whatever grazing is available. It is well suited to wildlife habitat. Capability unit VIIIs-1; Undesirable windbreak suitability group; no range site assigned.

Rock Land

Rock land (30 to 100 percent slopes) (Rk) is in very steep areas, mainly nearly vertical and vertical areas of rock outcrop along the bluffs of the Platte River Valley. Small areas are along the steep banks of large drainageways. The areas are 50 to 80 percent very shallow soils over sandstone or limestone; 10 to 45 percent of immature soils that formed in loess, glacial till, or shale; and about 10 percent bare rock. Areas are long and narrow and range from 10 to 30 acres in size.

Included with this land in mapping were small areas of Dickinson soils on the highest elevations. Also included were small areas of soils that are shallow and moderately deep over bedrock.

Droughtiness is the main hazard. Steepness and the high percentage of rock outcrop cause very rapid runoff.

About 60 percent of this land supports a thin stand of grasses, and 30 to 40 percent is in shrubs and trees. The rest is bare rock. This land type is not suitable for cultivation. It is too steep, too rocky, and lacks the characteristics of soil. Areas of Rock land are generally managed as range and used for whatever grazing is available. Cedar trees, brush, and weedy grasses are the main cover. In some places, limestone is quarried, crushed, and used to surface secondary roads. Capability unit VIIs-3; Savannah range site; Undesirable windbreak suitability group.

Rough Broken Land, Loess

Rough broken land, loess (30 to 100 percent slopes) (Rn) consists of very steep to nearly vertical areas of Peoria Loess that contain large gullies and deeply entrenched drainageways and overfalls. Areas range from 5 to 30 acres in size.

Included in mapping were small areas of glacial till. These areas are shown by a special symbol on the detailed soil map.

Water erosion is the main hazard. Runoff is very rapid. Soil slipping, which is common in steeper areas, forms short vertical steps, commonly called catsteps.

Rough broken land, loess, is not suitable for cultivation. Some areas are used for whatever grazing is available. Adjacent cultivated areas are used by wildlife for food, nesting, and cover. Some areas on the Missouri River Bluffs are parks used for recreation. The vegetation is trees, brush, and native grasses, mainly big bluestem, little bluestem, side-oats grama, switchgrass, and indiangrass. Capability unit VIIe-1; Thin Loess range site; Undesirable windbreak suitability group.

Sandy Alluvial Land

Sandy alluvial land (0 to 2 percent slopes) (Sd) consists of recent flood deposition adjacent to river and stream channels. The soil material is mixed with stratified sandy and loamy material that is moderately deep, shallow, or very shallow over the underlying coarse sand and gravel. The areas are dissected by numerous abandoned river channels, and during highest stream flow, these channels are filled with water. These areas are well drained, somewhat poorly drained, or very poorly drained. Depth to the water table ranges from 2 to 6 feet. Areas range from 10 to 100 acres in size.

Included with this land type in mapping were small areas of Platte, Inavale, Sarpy, and Alda soils and Wet alluvial land.

Flooding is a major hazard to vegetation and wildlife. Organic-matter content and natural fertility are low. Runoff is very slow or ponded.

Sandy alluvial land is not suitable for cultivation. Most areas are managed with other pasture and used for whatever grazing is available. Bluegrass is the dominant cover, but brush and trees are also common. Capability unit VIw-7; Subirrigated range site; Undesirable windbreak suitability group.

Sarpy Series

The Sarpy series consists of deep, nearly level to very gently sloping, excessively drained soils. These soils formed on bottom lands adjacent to the Missouri River in coarse-textured, calcareous, alluvial deposits that are occasionally flooded. Depth to the water table ranges from 8 to 10 feet.

In a representative profile the surface layer is very dark grayish-brown fine sand about 6 inches thick. The transitional layer is dark grayish-brown fine sand about 12 inches thick. The underlying material is brown fine sand to a depth of 60 inches.

Permeability is rapid, and available water capacity is low. Moisture is released readily to plants.

These soils are not suited to cultivated crops. They are suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Sarpy fine sand in a cultivated field 0.4 mile west and 0.15 mile south of the northeast corner of sec. 36, T. 16 N., R. 13 E.:

A—0 to 6 inches, very dark grayish-brown (10YR 3/2) fine sand, dark grayish brown (10YR 4/2) dry; single grained; loose; violent effervescence; abrupt, smooth boundary.

AC-6 to 18 inches, dark grayish-brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2) dry; single grained; loose; violent effervescence; clear, smooth boundary.

C—18 to 60 inches, brown (10YR 5/3) fine sand, light brownish gray (10YR 6/2) dry; single grained; loose; violent effervescence.

The A horizon ranges from 4 to 10 inches in thickness. The C horizon ranges from loamy fine sand to sand.

Sarpy soils are near Albaton, Carr, Haynie, Onawa, and Percival soils. They are coarser textured than Albaton, Carr, Haynie, and Onawa soils. They are coarser textured in the A horizon and in the upper part of the C horizon than Percival soils.

Sarpy fine sand (0 to 2 percent slopes) (Sp).—This soil is on higher parts of the bottom lands adjacent to the Missouri River. Areas range from 10 to 50 acres in size.

Included with this soil in mapping were small areas of Carr fine sandy loam.

Runoff is slow to very slow, and most of the rainfall is absorbed as rapidly as it falls. Soil blowing is the main hazard. The soil is droughty because the available water capacity is low. A few areas have active blowouts. Organic-matter content and natural fertility are low.

This soil is not suitable for crop production because it is too coarse textured and the hazard of erosion is too great. Most of the acreage is in weeds, scattered trees, and some grass. Capability unit VIs-6; Sandy Lowland range site; Very Sandy windbreak suitability group.

Silty Alluvial Land

Silty alluvial land (0 to 7 percent slopes) (Ss) is in frequently flooded areas along stream channels that are deeply entrenched in places. The soil material is dominantly silt loam or light silty clay loam. In places, 50 percent of this land type consists of deeply cut creek channels and the adjoining streambanks and breaks. The banks are covered with trees in most places. The rest of this land type consists of nearly level areas that are cleared of trees and contain bromegrass or native grasses. Areas are long and narrow and 10 to 40 acres in size.

Included with this soil in mapping were small areas of Judson silt loam and Kennebec silt loam.

Wetness from flooding is the main hazard. During periods of heavy rainfall, these areas are commonly under water. Runoff is slow.

Silty alluvial land is not suitable for cultivation because the hazard of flooding is too severe. It is used mainly for pasture and wildlife habitat. Capability unit VIw-7; Silty Overflow range site; Undesirable windbreak suitability group.

Slickspots

Slickspots consists of deep, moderately to strongly saline-alkali soil material in scattered areas on bottom lands in the Platte and Elkhorn River Valleys. The soil material contains salts that accumulated through the rise and the subsequent evaporation of saline ground water. The concentration of sodium makes the soil structure poor. Areas range from 5 to more than 100 acres in size.

In a representative profile the surface layer is very dark brown silt loam about 6 inches thick. The next layer is dark-gray silt loam about 9 inches thick. The subsoil is very dark gray, very sticky silty clay 5 inches thick. The underlying material is dark-gray, friable silt loam in the upper part. The lower part is light brownish-gray silt loam to a depth of 60 inches.

Salts are concentrated in small, scattered, white accumulations in the subsoil and underlying material. Because these horizons are so saline and alkaline, few roots penetrate them.

The surface layer ranges from 6 to 15 inches in thickness. The underlying material ranges from silt loam to silty clay. Concentrations of salts and of sodium range from slight to moderate throughout.

Slickspots is somewhat poorly drained. Permeability and runoff are slow. Erosion is not a hazard. Areas of Slickspots release moisture slowly to plants and are droughty.

Slickspots is mapped only with Gibbon soils. It is also associated with Luton and Wabash soils, but areas are small and not so numerous. In areas of Luton and Wabash soils, Slickspots is indicated by a special symbol on the detailed soil map.

Areas of Slickspots are better suited to crops or grass that tolerate salts and alkali. Most of the acreage is in cultivated crops, mainly wheat, corn, and grain sorghum. Small acreages are in soybeans and alfalfa. Production is generally poor unless a high level of management is used.

Steinauer Series

The Stenauer series consists of deep, well-drained, immature soils that formed in calcareous loamy glacial till (fig. 9). They are moderately steep to steep and are on bluffs along the Platte and Elkhorn River Valleys.

In a representative profile the surface layer is grayish-brown clay loam about 6 inches thick. A transitional layer is yellowish-brown clay loam about 12 inches thick. The underlying material, to a depth of 60 inches, is yellowish-brown clay loam.

Permeability is moderate, and available water capacity is moderate. Moisture is released slowly to plants.

Figure 9.—**Profile of Steinauer clay loam. The underlying material is glacial till.**

These soils are not suited to cultivated crops because they are too steep and the erosion hazard is too severe. They are better suited to grass. They are also suited to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Steinauer clay loam, 11 to 30 percent slopes, eroded, in a cultivated field 0.15 mile south and 0.1 mile east of the northwest corner of sec. 35, T. 15 N., R. 10 E.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) clay loam, light brownish gray (10YR 6/2) dry; weak, fine, granular structure; hard, firm; violent effervescence; moderately alkaline; abrupt, smooth boundary.

AC—6 to 18 inches, yellowish-brown (10YR 5/6) clay loam, pale brown (10YR 6/3) dry; weak, medium and fine, subangular blocky structure; hard, firm; violent effervescence; moderately alkaline; clear, wavy boundary.

C1—18 to 36 inches, yellowish-brown (10YR 5/6) clay loam, pale brown (10YR 6/3) dry; moderate, coarse and medium, blocky structure; hard, firm; violent effervescence; moderately alkaline; clear, wavy boundary.

C2—36 to 60 inches, yellowish-brown (10YR 5/6) clay loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm; violent effervescence; moderately alkaline.

The A horizon ranges from 4 to 7 inches in thickness. The depth to lime ranges from near the surface to about 14 inches. The AC horizon ranges from 7 to 14 inches in thickness. The C horizon ranges from heavy loam to clay loam and contains seams or pockets of sand and gravel.

Steinauer soils are near Marshall, Monona, Ponca, and Ida soils. They formed in clay loam glacial till, whereas Marshall, Monona, Ponca, and Ida soils formed in Peoria Loess. They have lime higher in the profile than Marshall, Monona, or Ponca soils, and they lack the B horizon typical of those soils. They have a finer textured C horizon than Ida soils, which formed in loess.

Steinauer clay loam, 11 to 30 percent slopes, eroded (StE2).—This soil is on uplands and commonly occurs as a band midway along hillsides. It also occurs on ridge points. Areas range from 10 to 20 acres in size.

Included with this soil in mapping were small areas of similar soils that have slopes of only 7 to 11 percent and some areas that have a surface layer 7 to 12 inches thick. Also included were small areas of Loveland Loess.

This soil is difficult to till because it has a very firm consistence and contains scattered rounded stones. Runoff is medium to rapid. Water erosion is the main hazard. Organic-matter content and available nitrogen are low. Because the soil is high in lime content, the available phosphorus is low.

A small part of the acreage is in cultivated crops, mainly corn, soybeans, and wheat. Small acreages are in grain sorghum and alfalfa. The slope, low fertility, and erosion hazard of this soil make it best suited to range. Most areas are in range. This soil is also used for wildlife habitat. Capability unit VIe-9; Limy Upland range site; Undesirable windbreak suitability group.

Wabash Series

The Wabash series consists of deep, nearly level, poorly drained soils on bottom lands in the Elkhorn and Platte River Valleys. These soils formed in alluvial sediments that are mainly clayey. Depth to the water table ranges from 3 to 8 feet.

In a representative profile the surface layer is black silty clay about 11 inches thick. The transitional layer is black silty clay about 10 inches thick. The underlying

material, to a depth of 60 inches, is silty clay. It is black in the upper 10 inches and dark gray in the lower 29 inches.

Permeability is very slow, and surface drainage is poor. Available water capacity is moderate. The surface layer is medium acid, and the transitional layer and underlying material are slightly acid. Moisture is released slowly to plants.

Wabash soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Wabash silty clay in a cultivated field 100 feet west and 2,112 feet south of the northeast corner of sec. 6, T. 16 N., R. 10 E.:

Ap—0 to 7 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak, fine, granular structure; hard, very sticky; medium acid; abrupt, smooth boundary.

A12—7 to 11 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate, medium and fine, subangular blocky structure parting to weak, very fine, subangular blocky; hard, very sticky; medium acid; clear, wavy boundary.

AC—11 to 21 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate, medium and fine, subangular blocky structure parting to weak, fine and very fine, angular blocky; hard, very sticky; slightly acid; clear, wavy boundary.

C1—21 to 31 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate, coarse and medium, angular blocky structure parting to massive; hard, very sticky; slightly acid; clear, wavy boundary.

C2—31 to 60 inches, dark-gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; massive; hard, very sticky; slightly acid.

The A horizon ranges from silt loam to silty clay. It is 10 to 20 inches thick. In places, the AC horizon and C horizon have a few lime concretions.

Wabash soils are near Gibbon and Luton soils and Slickspots. They have a noncalcareous profile, whereas Luton soils are calcareous. They have a fine-textured C1 and C2 horizon, whereas Gibbon soils are medium textured and moderately fine textured in this part of the profile. They are not so highly alkaline as areas of Slickspots.

Wabash silt loam (0 to 1 percent slopes) (Wo).—This soil is on the bottom lands in the Elkhorn and Platte River Valleys. It is commonly adjacent to an old stream channel that overflowed in past years. This soil has a profile similar to that described as representative of the series, but the surface layer is composed of 10 to 20 inches of silt loam alluvium. Areas range from 10 to 50 acres in size.

Included with this soil in mapping were a few areas of Wabash silty clay and Gibbon silty clay loam.

This soil is easier to till and the surface layer dries more quickly than Wabash soils that have a silty clay surface layer. Runoff is very slow. During periods of heavy rainfall, the very slow permeability of the underlying material causes the surface layer to remain wet for longer periods of time. This delays tillage. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly wheat, corn, and soybeans. Small acreages are in grain sorghum and alfalfa. Capability unit IIIw-2; Silty Overflow range site; Moderately Wet windbreak suitability group.

Wabash silty clay (0 to 1 percent slopes) (Wc).—This soil is on bottom lands in the Elkhorn and Platte River Valleys. In places, it is in old abandoned channels and on the lower part of the landscape. This soil has the profile described as representative of the series. Areas range from 10 to 200 acres in size.

Included with this soil in mapping were a few areas of Gibbon silty clay loam and areas of Wabash soils that have a silty clay loam surface layer.

This soil is difficult to till. Runoff is very slow. Surface drainage is the main concern in management. Wetness is the main hazard. Surface water stands in depressions and low areas for several days after a rain. Tillage is delayed, and the soil is slow in warming up in spring. Most of these areas are plowed in fall. Unless snow cover is adequate, soil blowing can be a minor hazard in winter. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly wheat, corn, and soybeans. Small acreages are in grain sorghum. Capability unit IIIw-1; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Wann Series

The Wann series consists of deep, nearly level, somewhat poorly drained soils on bottom land in the Platte and Elkhorn River Valleys. Depth to the water table ranges from 2 to 6 feet.

In a representative profile the surface layer is black fine sandy loam about 10 inches thick. The transitional layer is very dark gray fine sandy loam about 13 inches thick. The underlying material extends to a depth of 60 inches. It is grayish-brown fine sandy loam in the upper part and light brownish-gray fine and coarse sand in the lower part.

Permeability is moderately rapid, and available water capacity is moderate. The surface layer is mildly alkaline. Moisture is released readily to plants.

Wann soils are suited to cultivated crops. They are also suited to grass and to windbreak plantings. They provide habitat for wildlife and suitable sites for some types of recreation.

Representative profile of Wann fine sandy loam in a cultivated field 528 feet west and 50 feet south of the northeast corner of sec. 5, T. 15 N., R. 10 E.

Ap—0 to 6 inches, black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak, fine, granular structure; slightly hard, very friable; mildly alkaline; abrupt, smooth boundary.

A12—6 to 10 inches, black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak, fine, granular structure; slightly hard, very friable; mildly alkaline; clear, wavy boundary.

AC—10 to 23 inches, very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry; weak, fine and very fine, subangular blocky structure parting to weak, fine, granular; slightly hard, very friable; mildly alkaline; abrupt, smooth boundary.

C1—23 to 50 inches, grayish-brown (10YR 5/2) fine sandy loam, light gray (10YR 7/2) dry; many, fine, reddish-brown (5YR 5/3) mottles; massive; slightly hard, very friable; violent effervescence; moderately alkaline; abrupt, smooth boundary.

C2—50 to 60 inches, light brownish-gray (10YR 6/2) fine and coarse sand, very pale brown (10YR 7/3) dry; many, large, reddish-brown (5YR 5/3) mottles; single grained; loose; mildly alkaline.

The A horizon ranges from 11 to 20 inches in thickness. Lime generally is in the lower part of the A horizon and more commonly is in the C horizon. Thin strata of loam or loamy sand, 1 to 3 inches thick, are common in the C horizon.

Wann soils are near Alda, Cass, Gibbon, and Inavale soils. They are deeper than Alda soils. They are not so well drained as

534-869 O - 75 - 3

Cass soils. They have a coarser textured C1 horizon than Gibbon soils. They have a finer textured C1 horizon than Inavale soils.

Wann fine sandy loam (0 to 1 percent slopes) (Wm).—This soil is on bottom land in the Platte and Elkhorn River Valleys. The water table fluctuates between depths of 2 and 6 feet. Areas range from 10 to 50 acres in size.

Included with this soil in mapping were a few areas of Wann soils that have a very fine sandy loam and silt loam surface layer and areas of Gibbon silt loam.

This soil is easy to till. Runoff is slow. Wetness is the main hazard. The water table fluctuates widely. It is high in spring and falls in mid-summer during peak plant growth and evaporation. Soil blowing is a minor hazard on fallow land. Organic-matter content is moderate.

Most of the acreage is in cultivated crops, mainly corn, soybeans, and wheat. Small acreages are in grain sorghum and alfalfa. Capability unit IIw–6; Subirrigated range site; Moderately Wet windbreak suitability group.

Wet Alluvial Land

Wet alluvial land (0 to 1 percent slopes) (Wt) consists of frequently flooded, poorly drained, low bottom land areas within and adjacent to old, abandoned channels of the Platte, Elkhorn, and Missouri Rivers. These areas are flooded during heavy rains and during periods of high stream flow. The water table is generally at a depth of less than 2 feet, but it is above the surface for part of the year. Areas range from 10 to 20 acres in size.

Included with Wet alluvial land in mapping were small areas of Gibbon soils, Platte soils, and areas of marsh.

The surface layer ranges from fine textured to moderately coarse textured, but is commonly medium textured and moderately coarse textured. The underlying material is variable. It is mainly grayish in color and can be gleyed layers of olive, greenish, or bluish. Coarse sand and gravel is at depths of 10 to 36 inches.

Unless drained, this land is not suited to cultivated crops. Nearly all the acreage is used for pasture, but small areas surrounded by cultivated fields (fig. 10) are used as wildlife habitat. The principal native vegetation is sedges, prairie cordgrass, and reedgrass. In larger areas that have been overgrazed, bluegrass is the principal grass. Channelled areas have willow and cottonwood trees. Capability unit Vw–7; Wet Land range site; Undesirable windbreak suitability group.

Use and Management of the Soils

Much of the acreage in Douglas and Sarpy Counties is used for dryland crops. General practices of good soil management for cultivated crops are suggested in the pages that follow. The capability grouping used by the Soil Conservation Service is explained, and the capability units in the survey area are described. Estimated yields of the principal crops, under two levels of management, are given. A brief section on range provides suggestions for range management and descriptions of the soils and grasses in each range site. The woodland and windbreaks section gives information on the native woodland, the suitability of the soils for windbreaks, and the trees suited to each windbreak suitability group. Following this section are suggestions on selection of plants for environmental plantings. The section on wildlife describes wildlife habitat in each of the soil associations in the counties. Data from engineering tests and interpretations of soil properties that affect highway construction and other engineering structures are shown in tables 6, 7, and 8.

Management of Crops [3]

The soils of Douglas and Sarpy Counties are fertile and, if well managed, are well suited to crops. Their chief concerns in management are the control of water erosion on upland soils, the flooding of lands adjacent to streams, and the maintenance of high fertility. About 18 percent of the soils in the counties have a slope of more than 10 percent. Some areas of strongly sloping Ida, Monona, Ponca, and Marshall soils were cultivated in the past but have now been seeded to grass. Because runoff is excessive, water erosion is a serious hazard on these upland soils, and in many years, both sheet and gully erosion are evident. Much of the original surface layer of these soils has been washed away, and the soil material has been deposited in the valleys. Thus, fertility of the soils in the uplands has been reduced.

Corn is the main row crop in Douglas and Sarpy Counties, but soybeans is also important. If flooding is not a hazard, row crops are grown extensively on such bottom land soils as Albaton, Luton, Wabash, Cass, Carr, and Haynie soils. Row crops are also grown on large acreages of Marshall, Monona, Ponca, and Ida soils on uplands.

Oats, wheat, alfalfa, and pasture grasses are other major crops. Barley and rye are grown on a small acreage. Some areas formerly used for crops are now idle. Most of the idle areas are part of the diverted acreage in the government crop control programs.

Pastures make up only a very small part of these two counties. Most pastures are bromegrass or a mixture of bromegrass and alfalfa, and they are part of a long-term cropping system. Such use is especially well suited to the severely eroded, steep soils and soils that are frequently flooded.

Irrigated cropland in Douglas and Sarpy Counties makes up only a small part of the total acreage. According to the 1971 Nebraska Agricultural Statistics report, 6,100 acres in Douglas County and 5,500 acres in Sarpy County were irrigated. The irrigation water is used chiefly to supplement natural rainfall during years of below normal precipitation. Soils that are level to very gently sloping are the most suitable for irrigation. On slopes of more than 8 percent, irrigation causes water erosion and loss of irrigation water through excessive runoff.

If adequate quantities of underground water are available, the acreage of irrigated pasture and range can be increased. Management, particularly on gently sloping soils, also can be further improved.

Suitable practices for controlling erosion are terracing, contour farming, and grassed waterways. A cropping system that includes mulch tillage and limits the number of row crops is needed on the gently sloping and moderately sloping Monona, Marshall, and Ponca soils. Soils on bottom land, such as Onawa, Percival, Colo, Kennebec, and Alda soils, commonly require some protection from flood-

[3] Prepared by E. O. PETERSON, conservation agronomist, Soil Conservation Service.

***Figure 10.*—Wet alluvial land. Such areas are best suited to pasture and wildlife.**

ing. Flooding can be reduced by diversion terraces on upland areas above the flooded areas and by other supplemental practices that help conserve soil and water.

Producing enough crop residue to maintain erosion control is not always possible on the steepest Ida, Monona, Marshall, and Ponca soils. A cover of grass or hay crops, therefore, is needed to protect these soils and the sloping soils in pasture.

Leaving all crop residue on the surface during tillage helps to reduce losses of soil through water erosion and soil blowing. Stubble mulching and tillage planting in preparing the seedbed reduce sedimentation.

Fertilizer should be applied according to results of soil tests. The amount of moisture in the soil also should be considered. For example, less fertilizer is needed on soils that have a dry subsoil during a period of low rainfall than during a year when the supply of moisture is adequate. Crops on nearly all soils respond to applications of nitrogen. Phosphorus and zinc are commonly needed on the eroded Monona, Ida, and Marshall soils.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

Those familiar with the capability classification (*2*) can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitation of groups of soils for range, for forest trees, or for engineering.

In the capability system, all kinds of soil are grouped at three levels: the capability class, subclass, and unit. These levels are described in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are subject to little or no erosion, but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, water supply, or esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry. In Sarpy and Douglas Counties, there are no soils with a subclass designation of "*c*."

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture or range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIw-4. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management by capability units

On the following pages the capability units in Douglas and Sarpy Counties are described, and suggestions for the use and management of the soils are given. The names of the soil series and land types represented are mentioned in the description of each unit, but this does not mean that all the soils of a given series are in that unit. The capability unit designation for each soil in the county can be found in the "Guide to Mapping Units."

The capability units in this survey are not numbered consecutively within the subclass because they are part of the statewide system of capability classification, and not all of the capability units in the State are represented in these two counties.

The soils of Douglas and Sarpy Counties are grouped into capability units in accordance with their suitability for crops grown without irrigation.

CAPABILITY UNIT I-1

This unit consists of soils of the Cass, Eudora, Haynie, Marshall, and Monona series. These are deep, nearly level, well drained to moderately well drained soils on uplands and bottom land. Their surface layer is silt loam, very fine sandy loam, or silty clay loam. The subsoil and underlying material range from silty clay loam to fine sandy loam.

These soils are easy to till. They absorb moisture easily and release it readily to plants. Permeability is moderate and moderately rapid. The available water capacity is moderate in the Cass soil and high in the rest. Runoff is slow. The organic-matter content is low in the Haynie soils and moderate or high in the rest.

These are good soils for cultivated crops. Limitations and hazards are minimal. Conserving water is essential during periods of below average rainfall.

These soils are suited to all crops commonly grown in the counties, especially such row crops as corn, soybeans, and grain sorghum. Row crops can be grown year after year if proper amounts of fertilizer are applied and if weeds and insects are controlled. These soils are also suited to other crops and pasture grasses (fig. 11). Grassed waterways are commonly needed to conduct runoff across these soils. In places, diversion ditches help to prevent damage caused by runoff from higher areas. Planting grass in the turn rows and field rows helps to control weeds along field borders.

CAPABILITY UNIT IIe-1

This unit consists of soils in the Judson, Marshall, and Monona series. These are deep, uneroded, gently sloping to moderately sloping, well-drained soils on uplands and foot slopes. Their surface layer is silt loam or silty clay loam. The subsoil and underlying material are silt loam or silty clay loam.

These soils are easy to till. They absorb moisture easily and release it readily to plants. Permeability is moderate, and available water capacity is high. The organic-matter content is high in the Judson soil and moderate in the rest. Runoff is medium.

Water erosion is the main hazard. Conserving water is essential, especially during periods of below average rainfall.

These soils are suited to all crops commonly grown in the counties. On long slopes, terracing, contour farming, and grassed waterways are beneficial in keeping water from concentrating in large amounts. A cropping system that includes grasses and legumes helps to control erosion,

Figure 11.—**Cass very fine sandy loam in foreground. It is in capability unit I-1. Soils in background are in capability classes III, IV, and VI.**

improves organic-matter content, maintains high fertility, and improves tilth. The many farmsteads in areas of these soils are well suited to windbreak plantings, pasture grasses, and garden crops.

CAPABILITY UNIT IIw-1

This unit consists of soils in the Onawa and Percival series. These are deep, nearly level, somewhat poorly drained soils on bottom land. Their surface layer is silty clay. The underlying material ranges from silt loam to loamy fine sand. The water table fluctuates between depths of 3 and 8 feet.

These soils are difficult to till because the content of clay is high. They absorb moisture slowly and release it slowly to plants. Permeability is slow in the upper part of these soils and moderate to rapid in the lower part. The available water capacity ranges from low to high. Runoff is slow. The organic-matter content is low.

Maintaining good tilth is the main concern in management. Wetness that delays fieldwork early in spring is the main hazard. During periods of rainfall, surface drainage is needed to maintain good tilth in low areas where ponding occurs. Late in summer when air temperature is high, droughtiness is commonly a hazard in areas of Percival soils.

These soils are better suited to corn, soybeans, and wheat than to other crops. Surface drainage, for example, arrangement of row direction, surface bedding, and field drains are needed in cultivated areas. Weed control is needed in ditches. Excessive compaction by machinery and livestock is to be avoided, particularly if the soils are wet, because it reduces permeability of air and water. Fall plowing is beneficial because it increases soil aggregation, but soil blowing is a hazard in fall-plowed areas. Leaving strips of unplowed soil in the field is an effective control measure.

CAPABILITY UNIT IIw-3

This unit consists of soils in the Colo and Kennebec series. These are deep, nearly level, somewhat poorly drained to moderately well drained soils on bottom land. They are occasionally flooded. Their surface layer is silty clay loam or light silty clay loam. The underlying material is silty clay loam or silt loam.

These soils are easy to till. They absorb moisture easily and release it readily to plants. Permeability is moderately slow or moderate. The available water capacity is high. The organic-matter content is high. Runoff is slow. Occasional flooding is the main hazard.

These soils are suited to all crops commonly grown in the counties. Corn, soybeans, and wheat are the main

crops. Alfalfa and other hay crops are commonly damaged by sediment unless the adjacent upland areas are protected by terraces or other erosion-control measures. If fertilized and well managed, these soils can be used for row crops year after year.

CAPABILITY UNIT IIw-4

This unit consists of soils in the Colo and Gibbon series. These are deep, somewhat poorly drained soils on bottom land. Their surface layer is silt loam or silty clay loam. The underlying material ranges from silty clay loam to coarse sand and gravel. These soils are wet during part of the year because a seasonal high water table fluctuates between depths of 2 and 8 feet.

These soils are easy to work. They absorb moisture easily and release it readily to plants. Permeability is moderately slow or moderate. The available water capacity ranges from low to high. The organic-matter content is moderate to high. Runoff is slow.

Wetness, particularly early in spring, is the main hazard. Occasional flooding and runoff from higher areas are the principal concerns in management.

These soils are suited to all crops commonly grown in the counties. Corn, soybeans, and grain sorghum are the main crops. Small grains seeded in spring are grown in a few areas. Alfalfa production varies because in some years the root zone is restricted by a high water table. Some areas are in grass and are used for pasture. Shallow drains can be used to remove impounded surface water. Drainage V-ditches and tile drains are beneficial in controlling the water table and wetness.

CAPABILITY UNIT IIw-6

This unit consists of soils in the Gibbon and Wann series. These are deep and moderately deep, somewhat poorly drained soils on bottom land. The surface layer is fine sandy loam or loamy sand. The underlying material is fine sandy loam or silt loam. Depth to the water table fluctuates between 2 and 8 feet.

These soils are easy to work. They absorb moisture easily and release it readily to plants. Permeability ranges from moderately slow to moderately rapid. The available water capacity ranges from low to high. The organic-matter content is moderate. Runoff is slow.

Wetness early in spring is a hazard during periods of above average rainfall, and occasional flooding, caused by ice jams on the Platte River, is a minor hazard during thaws early in spring. Late in summer, however, the supply of moisture is inadequate for crop growth.

These soils are better suited to corn, grain sorghum, and soybeans than to other crops. Fall-seeded wheat is a suitable crop, especially if wetness prevents crops from being planted in spring. The moderately high water table limits alfalfa production. If suitable outlets are available, shallow drains help in controlling the water table and increase crop production. The moderately coarse or coarse textured surface layer is subject to shifting by wind action if the soil is left bare. Cover crops and crop residue on the surface protect the soil from blowing.

CAPABILITY UNIT IIs-6

This unit consists of soils in the Carr and Cass series. These are deep, nearly level, well drained to moderately well drained soils on bottom land. Their surface layer is fine sandy loam, and the underlying material is fine sandy loam.

These soils are easy to till. They absorb moisture easily and release it readily to plants. Permeability is generally moderately rapid, but in some areas it is moderately slow in the lower part of the soil. Available water capacity is moderate to high. The organic-matter content is moderate to low. Runoff is slow.

Droughtiness is a hazard on these moderately coarse textured soils during periods of below average rainfall.

These soils are suited to all crops commonly grown in the counties. Mulch planting, crop residue, and a cropping system that includes grasses and legumes help in controlling erosion and in building up the supply of organic matter and in conserving moisture for use by crops. Irrigation water, if available, lessens the chance of crop failure caused by low rainfall.

CAPABILITY UNIT IIIe-1

This unit consists of soils in the Marshall and Monona series. These are deep, strongly sloping, well-drained soils on uplands. They are not appreciably eroded. Their surface layer, subsoil, and underlying material are silty clay loam or silt loam.

These soils are easy to till. They absorb moisture easily and release it readily to plants. Permeability is moderate. Available water capacity is high. The organic-matter content is moderate. Runoff is medium.

Water erosion is the main hazard. Conserving water is the main concern in management, especially during years of below average rainfall. These soils are easily and deeply penetrated by roots. They are suited to all crops commonly grown in the counties. The hazard of erosion is more severe if soybeans, a low residue crop, is grown than if other tilled crops are selected. Corn and sorghum produce more residue that can be used in a mulch planting system. Effective methods for controlling erosion are terraces, contour farming, grassed waterways, maximum use of crop residue, and minimum tillage.

CAPABILITY UNIT IIIe-5

Inavale loamy fine sand, the only soil in this unit, is a deep, somewhat excessively drained soil on bottom land. The underlying material is loamy fine sand and fine sand. The water table fluctuates between depths of 5 and 10 feet.

This soil is easy to till. It absorbs moisture easily and releases it readily to plants. Permeability is rapid. The available water capacity is low. The organic-matter content is low. Runoff is slow to very slow. Droughtiness is the main hazard.

This soil is suited to the crops commonly grown in the counties. A cover crop of rye or vetch can be used to protect the surface from soil blowing. Crops respond well to the application of fertilizer if adequate moisture is available. Maintaining and improving fertility are essential.

CAPABILITY UNIT IIIe-8

This unit consists of soils in the Ida, Marshall, Monona, and Ponca series. These are deep, eroded, moderately sloping to strongly sloping, well-drained soils on uplands. Their surface layer, subsoil, and underlying material are silt loam or silty clay loam.

These soils are easy to work. They absorb moisture easily and release it readily to plants. Permeability is moderate.

Available water capacity is high. The organic-matter content is low because much of the darkened surface has been eroded away. Runoff is medium to rapid.

Water erosion is the main hazard. Because these soils are eroded, they are low in nitrogen. Increasing fertility and conserving water are important management needs.

These soils are suited to most crops commonly grown in the counties, but they are highly erodible if a low-residue crop, such as soybeans, is grown. Growing such soil-building crops as grasses and legumes and returning all crop residue to the soil restore the structure and the organic-matter content. Contour farming, terraces, waterways, and field borders help prevent erosion, conserve moisture, restore fertility, and control runoff (fig. 12). In some areas stripcropping reduces the erosion hazard. Loss of fertility is serious on these eroded soils, and fertilizer is needed for good crop growth and production.

CAPABILITY UNIT IIIw-1

This unit consists of soils in the Albaton, Luton, and Wabash series. These are deep, nearly level, somewhat poorly drained to poorly drained soils on bottom land. Their surface layer is silty clay or silty clay loam. The underlying material is silty clay. The water table fluctuates between depths of 3 and 8 feet.

These soils are difficult to till because they are very firm when moist. They absorb moisture slowly and release it slowly to plants. Permeability is very slow. The available water capacity is moderate. The organic-matter content is low to moderate. Runoff is very slow or slow.

Wetness in spring and after rain is the main hazard. The soils dry out slowly, and during periods of rainfall, they are ponded because permeability is very slow. Good surface drainage is needed in order to maintain good tilth. Maintaining good tilth is an additional concern in management.

Wheat, corn, and soybeans are the main crops on these soils. Because internal drainage is slow, water ponds occasionally on the surface and delays planting or drowns the crop. Adding organic material and avoiding tillage when the soil is wet prevent puddling and improve tilth. The high clay content makes tillage difficult. If these soils are plowed when wet, large clods form.

Plowing in fall improves the structure of these soils and provides a better seedbed because freezing and thawing during the winter breaks down the large clods. If soils are left bare, however, they are susceptible to blowing. Field windbreaks, wind stripcropping, and cover crops are beneficial in controlling soil blowing. Excessive compaction by machinery or livestock reduces permeability of

Figure 12.—**Contour farming, stripcropping, and terracing to control erosion on Marshall-Ponca silty clay loams, 7 to 11 percent slopes, eroded.**

air and water. Growing mixtures of grasses and legumes in the cropping system helps to maintain high fertility and improves tilth.

Permeability is too slow in these soils for tile drains to effectively control wetness. Shallow surface V-drains can be used to remove excess surface water. Row arrangement, surface bedding, field drains, and control of weeds in drainage ditches also help to improve surface drainage.

CAPABILITY UNIT IIIw-2

This unit consists of soils in the Albaton, Luton, and Wabash series. These are deep, nearly level, poorly drained soils on bottom land. Their surface layer is silt loam. The underlying material is silty clay. The water table fluctuates between depths of 3 and 8 feet.

These soils are easy to till. They absorb moisture easily in the surface layer, but movement is slow in the subsoil and underlying material. Moisture is readily released to plants. Permeability is very slow. The available water capacity is moderate. The organic-matter content is low to moderate. Runoff is slow.

Wetness is the main hazard. Because permeability is very slow, water ponds during and following heavy rains and delays tillage and harvesting of crops.

These soils are suited to all crops commonly grown in the counties. Keeping tillage at a minimum and working the soil within only the proper moisture content will keep it from compacting under machinery. If the soil is compacted and aeration and water movement are reduced, it becomes difficult to till and to manage. Tile does not work well enough to correct wetness. Shallow surface drains reduce ponding, and diversions, field drains, row arrangement, and open drainage ditches help to improve surface drainage.

CAPABILITY UNIT IIIw-4

This unit consists of soils in the Alda series and the Lex series, noncalcareous variant. These are nearly level, moderately deep, somewhat poorly drained soils on bottom land. Their surface layer is mainly very fine sandy loam and silt loam, but in some areas it is loam and silty clay loam. The underlying material ranges from loam to fine sandy loam in the upper part. Mixed sand and gravel is below a depth of 20 to 40 inches. A water table is at a depth of 2 to 8 feet.

Permeability is moderate to moderately rapid in the upper part of the soil and very rapid in the mixed sand and gravel. The available water capacity ranges from low to moderate. Organic-matter content is moderate. Runoff is slow.

Wetness, particularly in spring, is the main hazard. These soils warm up slowly in spring, and seedbed preparation and planting are commonly delayed. Late in summer, when the water table is lowest, the supply of moisture is inadequate for crops.

These soils are suitable for all crops commonly grown in the counties. Rye and vetch can be used as cover crops and as green-manure crops. Crop residue that remains on the soil in winter reduces the hazard of soil blowing.

CAPABILITY UNIT IIIw-6

Alda fine sandy loam, the only soil in this unit, is a nearly level, moderately deep, somewhat poorly drained soil on bottom land. The underlying material is fine sandy loam. Mixed sand and gravel is between depths of 20 and 40 inches. A water table fluctuates between depths of 2 and 6 feet.

Permeability is moderately rapid in the upper part of the soil and very rapid in the mixed sand and gravel. Available water capacity is low. Organic-matter content is moderate. Runoff is slow.

Wetness, particularly early in spring, is the main hazard and commonly delays preparing the seedbed and planting. This soil warms up more slowly than better drained soils. Late in summer, when the water table is lowest, dryfarmed crops are damaged by lack of sufficient moisture.

This soil is well suited to corn, sorghum, grasses, and legumes. Maintaining a surface cover of crop residue or growing crops throughout the year reduces the hazard of soil blowing. In areas where suitable drainage outlets are available, tile or open-ditch drainage alleviates wetness to some extent. Supplemental irrigation water, particularly during the latter part of the growing season, is needed for maximum crop production.

CAPABILITY UNIT IVe-1

This unit consists of soils in the Marshall, Monona, and Ponca series. These are deep, uneroded, moderately steep, well-drained soils on uplands. Their surface layer, subsoil, and underlying material are silty clay loam or silt loam.

These soils are easy to till. They absorb moisture easily and release it readily to plants. Permeability is moderate. Available water capacity is high. The organic-matter content is moderate. Runoff is medium to rapid.

Water erosion is the main hazard. Conserving water is the main concern in management, especially during periods of below average rainfall.

These soils are better suited to permanent grass or hay crops than to other crops. They are in grass or have been recently converted from grass to tilled crops. They are generally suited to crops commonly grown in these counties, but they are poorly suited to soybeans. Because the hazard of erosion is so severe, row crops, or clean-tilled crops, should not follow each other in the cropping sequence. Growing legumes and grass about 80 percent of the time and returning crop residue and barnyard manure to the soil help in controlling erosion, maintaining high fertility, and improving tilth. Contour farming, terraces, grassed waterways, stripcropping, and grassed turn rows also help in erosion control. A tillage system that leaves crop residue at or near the surface helps reduce runoff and increases the rate of water intake.

CAPABILITY UNIT IVe-8

This unit consists of soils in the Ida, Marshall, Monona, and Ponca series. These are deep, eroded, strongly sloping to moderately steep, well-drained soils on uplands. Their surface layer, subsoil, and underlying material are silty clay loam or silt loam. Small gullies are common in the natural drainageways.

These soils are not so easy to work as more friable soils that have a larger supply of organic matter. They absorb moisture easily and release it readily to plants. Permeability is moderate. Available water capacity is high. The organic-matter content is moderate to low. Runoff is medium to rapid.

Water erosion is the main hazard. Conserving water is an important concern in management. Improving fertility also is important because these soils are low in nitrogen.

These soils are suited to most crops commonly grown in these counties, but they are not suited to soybeans. Seeding grass and mixtures of grasses and legumes is beneficial in restoring organic-matter content and improving fertility. Contour farming and terracing are effective in conserving soil and moisture and controlling runoff. Grassed waterways, grassed turn rows, and seeded field borders can also be used. Maintaining a permanent plant cover, such as grass or trees, is most effective in conserving soil and water (fig. 13).

CAPABILITY UNIT IVe-9

Ida silt loam, 7 to 17 percent slopes, eroded, the only soil in this unit, is a deep, well-drained, strongly sloping to moderately steep soil on uplands. The surface layer and underlying material are silt loam.

This soil is easy to till. It absorbs moisture easily and releases it readily to plants. Permeability is moderate. Available water capacity is high. Organic-matter content is low. Runoff is rapid.

Water erosion is the main hazard. Conserving water is the main concern of management, especially during years of below average rainfall. Improving fertility is also important.

This soil is suited to most locally grown crops, but it is not suited to soybeans. The difficulty in maintaining fertility and the severe hazard of erosion make this soil better suited to grass, to mixtures of grasses and legumes, or to forage crops than to other grain or row crops. Some areas are in grass or trees and can be used for grazing, wildlife, or recreation.

CAPABILITY UNIT IVw-4

This unit consists only of Platte soils. These are shallow, somewhat poorly drained soils on bottom land. Their surface layer is loam or sandy loam. The next layer is loam. Coarse sand and gravel is at a depth of 10 to 20 inches. The water table fluctuates between depths of 2 and 5 feet.

Unless wet, these soils are easy to work. They absorb moisture easily and release it readily to plants. Permeability is moderate in the upper part of the soil and very rapid in the underlying sand and gravel. The available water capacity is low. Runoff is slow. The organic-matter content is low.

Excessive wetness early in spring, when the water table is high and rainfall is heavy, is the main hazard. In low places flooding is a minor hazard. Droughtiness is a hazard late in summer and in fall because the water table is low and no capillary action is possible in the sand and gravel underlying material.

These soils are better suited to pasture or meadow than to other crops. Irrigation is needed to obtain a satisfactory

Figure 13.—Landscape of Monona and Ida silt loams, 11 to 17 percent slopes, eroded. Capability unit IVe-8. These areas have potential for development as homesites.

level of production if grain crops are grown. Removing excess water early in spring is essential. Surface drains are helpful if suitable outlets are available. A cropping system is needed that provides maximum crop residue on the surface to protect the soil from excessive soil blowing.

CAPABILITY UNIT IVs-1

This unit consists only of the Gibbon-Slickspots complex. These are deep, nearly level soils on bottom land. The surface layer is silt loam. The underlying material ranges from silt loam to silty clay. The water table fluctuates between depths of 2 and 6 feet. The Slickspots part of this complex is strongly alkaline or very strongly alkaline.

This complex is difficult to work. It absorbs moisture slowly and releases it slowly to plants. Permeability is moderate or slow. The available water capacity is moderate. Runoff is slow. The organic-matter content is low.

Alkalinity is the main hazard. Wetness is a hazard early in spring. Management that improves tilth and increases the organic-matter content is needed.

Winter wheat is better suited than other crops because the seedbed can be established in fall when the soils are not so wet, and the wheat can be harvested in summer when they are likely to be dry. Alkali-tolerant tall wheatgrass is suitable permanent vegetation. It can be used for either hay or pasture. Land smoothing and surface drains reduce soil wetness.

CAPABILITY UNIT Vw-7

This unit consists only of Wet alluvial land in old abandoned river channels and basins on bottom land. The soil material varies widely in texture, but is mainly loamy and sandy. Depth to the underlying sand ranges from 10 to 60 inches. A water table fluctuates between the surface and a depth of 2 feet.

Wet alluvial land releases moisture readily to plants. Permeability is moderate to rapid, but this fact is not significant unless the areas are drained or the water table is lowered. Runoff is slow or ponded. The high water table is the main feature that affects use and management.

Wetness is the main hazard. Flooding is common following heavy rain.

Wet alluvial land is better suited to pasture, range, and wildlife habitat than to other uses. It is so wet during some seasons that grazing is limited. Most areas are in tall and mid grasses and have trees at the outer edges. If suitable outlets are available, surface tile can be installed to lower the water table and provide drainage so that more desirable grasses can be established.

CAPABILITY UNIT VIe-1

This unit consists only of Monona and Ida silt loams, 17 to 30 percent slopes. These are deep, well-drained soils on uplands. The surface layer, subsoil, and underlying material are silt loam.

These moderately steep to steep soils are hard to work. They absorb moisture easily and release it readily to plants. Permeability is moderate. The available water capacity is high. The organic-matter content ranges from low to moderate. Runoff is rapid to very rapid.

Water erosion is the main hazard. Conserving moisture is a concern in management. If the grass and tree cover is removed, the soils erode easily.

These soils are well suited to grass and trees. If they are used for grazing, spraying helps to control weeds and other undesirable plants. Nearly all areas are now in grass or trees and should remain in this type of plant cover. Serious erosion is common if the plant cover is removed.

CAPABILITY UNIT VIe-3

This unit consists only of Dickinson soils, 11 to 17 percent slopes. These are deep, somewhat excessively drained, moderately steep soils on uplands. Their surface layer, subsoil, and underlying material are fine sandy loam.

These soils are easy to till. They absorb moisture easily and release it readily to plants. Permeability is moderately rapid. The available water capacity is moderate. Organic-matter content is moderate. Runoff is medium. Water erosion is the main hazard.

These soils are not suited to cultivated crops. All cultivated areas should be planted to grass and used for pasture or range. Other suitable uses are woodland, windbreaks, and wildlife habitat.

CAPABILITY UNIT VIe-5

Inavale loamy fine sand, hummocky, the only soil in this unit, is a deep, somewhat excessively drained soil on bottom land. It is on low ridges 8 to 15 feet above the adjacent soils. The underlying material is loamy fine sand and fine sand.

This soil takes in moisture easily. Permeability is rapid. The available water capicity is low. Runoff is slow to very slow. The organic-matter content is low.

Soil blowing is a hazard in unprotected areas. Droughtiness also is a hazard on this sandy soil. The growth of vegetation is adversely affected by lack of moisture in summer.

This soil is not suited to cultivated crops. Because it is sandy, it is susceptible to soil blowing and to some water erosion if cultivated. It is suited to grass and trees and to use as wildlife habitat.

CAPABILITY UNIT VIe-8

This unit consists only of Monona and Ida silt loams, 17 to 30 percent slopes, eroded. These are deep, moderately steep to steep, well-drained soils on uplands. Their surface layer, subsoil, and underlying material are silt loam. These soils are eroded, and small gullies are common.

These soils are easy to work. They absorb moisture easily and release it readily to plants. Permeability is moderate. The available water capacity is high. Organic-matter content is low to high. Runoff is rapid.

Water erosion is the main hazard. Because runoff is rapid, conserving moisture is an important concern in management. Gullies and rills are common.

These soils are better suited to grass and trees than to cultivated crops. Areas that are now cultivated should be converted to grass or trees and used for grazing, wood production, or recreation. Under good management, an adequate cover of plants can be maintained and loss of soil, water, and plant nutrients can be reduced. Small isolated areas can be seeded to grass or planted to trees and shrubs for use by wildlife. Mixtures of native grasses, similar to the climax vegetation, are well suited. Good sites for watering livestock or for recreational dams occur along some areas of these soils. Further development of these sites is possible.

CAPABILITY UNIT VIe-9

This unit consists of soils in the Ida and Steinauer series. These are deep, eroded and uneroded, well-drained soils on uplands. Ida soils are steep, and Steinauer soils are moderately steep to steep. Their surface layer and underlying material are silt loam or clay loam.

These soils release moisture readily to plants. Permeability is moderate or slow. The available water capacity is moderate or high. Organic-matter content is low. Runoff is rapid.

Water erosion is the main hazard. Because runoff is rapid, conserving moisture is important.

Uneroded areas of these soils are in native grass and trees. Eroded areas are cultivated or have been reseeded to grass. Because the erosion hazard is severe in cultivated areas, these soils are better suited to grasses and trees than to cultivated crops. Under good management, an adequate cover of plants can be maintained and losses of soil and water reduced. In places, good sites are available for farm ponds and for wildlife. Proper range management is needed to keep the grass in good condition.

CAPABILITY UNIT VIw-7

This unit consists of Sandy alluvial land and Silty alluvial land. Sandy alluvial land consists of mixed and stratified sand, silt, and gravel and ranges in depth from very shallow to deep. It occupies frequently flooded areas commonly adjacent to rivers and stream channels. Silty alluvial land is deep silt loam or silty clay loam. It is along deeply entrenched stream channels in the uplands and is frequently flooded.

These land types absorb moisture easily and release it readily to plants. Permeability ranges from slow to very rapid. Available water capacity is low to high. Organic-matter content is low to moderate. Runoff is slow to ponded.

Wetness caused by frequent flooding is the main hazard. Erosion is a hazard because the moving waters continually deepen and widen the stream channels and damage growing plants.

These areas are suitable for grass or trees. Flooded areas that lack adequate cover can be planted to trees or reseeded to grass for grazing. Wooded and brushy areas that are not used for grazing provide excellent habitat for wildlife.

CAPABILITY UNIT VIs-6

Sarpy fine sand, the only soil in this unit, is a deep, excessively drained soil on bottom land. The surface layer and underlying material are loamy fine sand.

This loose sand is not easy to work. It absorbs moisture easily and releases it readily to plants. Permeability is rapid. Available water capacity is low. The organic-matter content is low. Runoff is slow to very slow.

Soil blowing is a serious hazard unless the soil is protected. Droughtiness also is a hazard. Conserving moisture is essential. Vegetation is affected early by prolonged dry spells.

This soil is better suited to grazing than to other uses. In cultivated areas it is subject to severe soil blowing. All cultivated areas should be converted to native grasses and used for grazing. A good cover of grass is needed at all times to avoid soil blowing.

CAPABILITY UNIT VIIe-1

This unit consists of soils of the Monona and Ida series and of Rough broken land, loess (fig. 14), and Gullied land. These are deep, very steep, well-drained areas on uplands. The surface layer and underlying material are silt loam.

Moisture is absorbed readily and released readily to plants. Permeability is moderate. The available water capacity is high. The organic-matter content ranges from high to low. Runoff is very rapid.

Water erosion is the main hazard. Because runoff is so rapid, conserving moisture is essential. Gullies and rills are common. Soil slippage is common and leaves short vertical slopes, commonly called "catsteps," in areas of Rough broken land, loess.

These areas can be used for limited grazing. They are also suitable sites for recreation, and they provide food and cover for upland game.

CAPABILITY UNIT VIIs-3

This unit consists only of Rock land, mainly shallow and very shallow soils and numerous outcrops of limestone, sandstone, shale, or glacial till. Rock land is on uplands and is excessively drained.

Permeability ranges from slow to very rapid. Available water capacity is low. Organic-matter content is low to moderate. Moisture is absorbed slowly and released readily to plants, and water runs off rapidly.

Droughtiness is the main hazard because the soil material is shallow over bedrock. Gullies and rills are common.

Rock land can be used for limited grazing, but extreme care is needed to avoid reducing the plant cover. In some places, rock is quarried for industrial use.

CAPABILITY UNIT VIIIs-1

This unit consists of Pits and dumps and Riverwash. The material is stratified coarse sand, gravel, and some silt. It ranges from excessively drained to very poorly drained. These land types are commonly in frequently flooded areas adjacent to stream and river channels.

Moisture is absorbed easily and released readily to plants. Permeability is very rapid. The available water capacity is very low. Organic-matter content is very low to low. Runoff is very slow.

Soil blowing is a major hazard. During periods of above average rainfall, frequent flooding is common. Most areas lack a plant cover, but some are partly stabilized by grass and shrubs. The soil material is droughty, and plant growth is poor.

These land types are not suited to crops or grass, but trees grow well in some scattered areas. Soil blowing is a severe hazard, and in places sand is piled into dunes. The spoilbanks of sandpits are suitable as recreational areas, especially if the banks have been smoothed. They can be used as cabin sites, and the water areas provide fishing and other recreation. Riverwash is better suited to recreation and wildlife habitat than to other uses.

Predicted yields

Predicted yields per acre for the principal crops grown in Douglas and Sarpy Counties are shown in table 2. These predictions are based on average yields for seeded acres over the most recent 5-year period. They do not rep-

Figure 14.—**Bluffs along the Missouri River provide wildlife habitat. This area is Rough broken land, loess. Capability unit VIIe-1.**

resent anticipated yields that might be obtainable in the future under a new and possibly different technology.

Predictions for various crops were derived from information obtained from interviews with farmers, supervisors of the Soil and Water Conservation Districts, representatives of the Soil Conservation Service and Agricultural Extension Service, and others familiar with the soils and agriculture of the county. Information from the Agricultural Stabilization and Conservation Service and research data from agricultural experiment stations were also used. Yield records, trends, research, and experience were considered.

Yields are influenced by many factors, for example, soil depth, texture, slope, drainage, erosion, available water capacity, permeability, and fertility. Yields also depend on the cropping pattern, timely fieldwork, plant population, and crop variety. Weather is significant, day to day and seasonal or yearly fluctuations. All of these were taken into account in preparing table 2.

Predicted yields are listed for two levels of management. Basically they reflect soil differences and different responses to management practices. Figures in columns A are yields obtained by using an average level of management. Figures in columns B are yields obtained under a superior type of management.

Under an average level of management, a moderate attempt is made at maintaining fertility, but the proper amount of fertilizer or the time of application is not necessarily that indicated by soil tests. Measures that control erosion and maintain tilth are not used as effectively as possible. Weed, disease, and insect control and certified seed are not always used consistently. Timeliness of fieldwork, the use of improved varieties of plants, and proper plant populations are lacking. Correcting these deficiencies is likely to result in significantly higher yields.

Under a high level of management, fertility is maintained, and fertilizer or lime is applied at rates indicated by soil tests and field experiments. Crop residue is returned to the soil to improve tilth and maintain or increase organic-matter content. Adapted varieties of seed are used, and plant populations are optimum. Weeds, insects, and diseases are well controlled. Application of irrigation water is timely and in the proper amount. Water erosion and soil blowing are controlled. If needed for crop production, the soils are drained. Tillage, seeding, and cultivation practices are adequate and are performed at the proper time. The soils are protected from deterioration and used according to capacity.

The table makes no recommendations, and the yields given do not apply to specific farms or farmers. The in-

TABLE 2.—*Predicted average yields per acre of principal dryland crops on arable soils*

[Figures in columns A indicate yields under average management; figures in columns B indicate yields under high-level management. Absence of figure indicates that the soil is not suited to the specified crop]

Soil	Corn		Soybeans		Grain sorghum		Wheat		Oats		Alfalfa	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Albaton silt loam, overwash	60	80	22	32	50	75	25	35			3.0	5.0
Albaton silty clay	50	75	20	30	48	70	20	30			2.8	4.8
Alda fine sandy loam	45	60	20	30	50	65	20	30			1.5	2.5
Alda very fine sandy loam	65	80	25	35	70	85	20	30			2.5	4.0
Carr fine sandy loam	65	90	20	30	55	70	20	30			3.0	5.0
Cass fine sandy loam	60	85	20	30	50	65	20	30			2.8	4.8
Cass fine sandy loam, loamy substratum	70	100	20	35	65	95	20	35			3.0	5.0
Cass very fine sandy loam	75	105	25	35	70	95	25	35			3.0	5.0
Colo silty clay loam	80	100	25	30	75	105	20	35			3.5	5.5
Colo and Kennebec soils	85	120	25	30	80	110	20	35			3.5	5.5
Eudora silt loam	90	120	35	45	90	120	25	40			3.0	6.0
Gibbon loamy sand, overwash	50	80	15	25	45	75	15	30			2.5	3.0
Gibbon silt loam	90	125	30	45	85	115	25	40			2.8	5.0
Gibbon silty clay loam	85	120	25	35	80	110	20	35			2.5	4.5
Gibbon-Slickspots complex	15	40					15	25				
Haynie silt loam	75	100	25	40	75	100	30	40	35	60	3.5	5.5
Ida silt loam, 7 to 17 percent slopes, eroded	30	50			25	50	10	30	10	25	2.5	3.5
Inavale loamy fine sand	20	45			20	45	10	20				
Judson silt loam, 3 to 7 percent slopes	80	105	35	42	70	95	30	40	40	70	3.5	5.0
Kennebec silt loam, occasionally flooded	80	110	35	45	95	105	25	35			3.5	5.5
Lex soils, noncalcareous variant	90	110	30	40	90	110	25	35			2.5	4.5
Luton silt loam, overwash	65	85	25	35	70	90	25	35			3.0	4.8
Luton silty clay loam	60	80	22	32	60	80	22	32			3.0	4.5
Luton silty clay	55	75	20	30	55	75	20	30			3.0	4.5
Marshall silty clay loam, 0 to 1 percent slopes	65	95	35	40	70	100	30	40	45	70	3.5	5.0
Marshall silty clay loam, 1 to 3 percent slopes	65	95	35	40	70	95	25	40	45	68	3.0	5.0
Marshall silty clay loam, 3 to 7 percent slopes	65	90	30	35	70	90	22	38	45	65	3.0	4.8
Marshall silty clay loam, 3 to 7 percent slopes, eroded	60	85	25	30	65	85	20	35	45	60	3.0	4.5
Marshall silty clay loam, 7 to 11 percent slopes	55	80			55	80	20	35	45	60	3.0	4.5
Marshall-Ponca silty clay loams, 7 to 11 percent slopes, eroded	55	75			55	75	20	32	40	55	3.0	4.2
Marshall and Ponca soils, 11 to 17 percent slopes	50	70			50	70	20	30	30	45	2.5	4.0
Marshall and Ponca soils, 11 to 17 percent slopes, eroded	45	65			45	65	20	28	30	45	2.5	4.0
Monona silt loam, 0 to 1 percent slopes	60	95	25	40	70	100	25	40	45	70	3.5	5.0
Monona silt loam, 1 to 3 percent slopes	70	95	25	40	70	95	25	40	45	70	4.0	5.0
Monona silt loam, 3 to 7 percent slopes	65	90	20	35	70	90	22	38	40	60	4.0	5.0
Monona silt loam, 3 to 7 percent slopes, eroded	65	85	15	30	65	85	20	35	40	55	4.0	4.8
Monona silt loam, 7 to 11 percent slopes	60	80			65	85	19	30	35	55	3.0	4.5
Monona silt loam, 7 to 11 percent slopes, eroded	55	75			60	80	18	28	35	50	2.5	4.2
Monona silt loam, 11 to 17 percent slopes	50	70			50	75	17	25	30	45	3.0	4.0
Monona and Ida silt loams, 11 to 17 percent slopes, eroded	40	65			45	75	15	20	25	35	2.5	3.0
Onawa silty clay	60	90	25	35	55	85	25	40			3.0	5.0
Percival silty clay	50	75	20	30	45	75	15	30			2.5	3.5
Platte soils	15	30			15	30	10	15				
Ponca and Ida silt loams, 7 to 11 percent slopes, eroded	45	65			65	80	18	28	35	50	2.5	4.5
Ponca and Ida silt loams, 11 to 17 percent slopes, eroded	40	60			45	65	15	20	30	35	2.5	3.0
Steinauer clay loam, 11 to 30 percent slopes, eroded	30	45			30	50						
Wabash silt loam	60	80	25	35	55	85	22	32			2.5	4.2
Wabash silty clay	50	75	22	30	45	60	20	30			2.4	4.0
Wann fine sandy loam	55	70	25	35	55	70	20	30			2.5	3.5

formation can be used to compare the productivity of one soil with another soil within the county.

Yields in any given year on a particular soil can vary considerably from the figures shown. This variance can be caused by the effect of weather or sudden infestations of diseases, insects, or other unpredictable hazards. By using longtime averages, it is possible to consider such hazards in arriving at the yield figures.

Improved technology may make the crop yield table obsolete in a few years. Yield data should be updated as knowledge is gained and improvements in technology show the need.

Management of Range [4]

The acreage of range, or native grassland, is very small in Douglas and Sarpy Counties. It is generally in small tracts, but is somewhat concentrated along the Missouri and Platte Rivers. The areas are generally not suitable for cultivation. The success of the range program depends on how the grass and feed reserves are managed.

Knowing the different kinds of range sites and the plants each site can grow is essential if the range is to be well managed. Management can then favor growth of the better forage plants.

Management that maintains or improves the condition of the range is needed, regardless of other practices used. Proper grazing use and deferred grazing are the most important.

Range seeding, or the establishment by seeding or reseeding of native grasses of improved strains, or wild harvest improves the range condition. Technical help in converting soils that are presently being used for crops can be obtained from the local Soil Conservation Service office. The kind of soils and the range site assigned to that soil are important in determining the best seeding program. No care other than management of grazing is needed to maintain the forage composition.

Range sites and condition classes

Range sites are distinctive kinds of range that differ from each other in their ability to produce a significantly different kind, proportion, or production of climax, or original, vegetation. A significant difference is one great enough to require some variation in management, such as as a different stocking rate. Climax vegetation is the combination of plants that originally grew on a given site. It is generally the most productive combination of range plants on a site.

Range condition is classified according to the percent of vegetation on the site that is original, or climax, vegetation. This classification is used for comparing the kind and amount of present vegetation with that which the site can produce. Changes in range condition are caused primarily by intensity of grazing and by drought.

Climax vegetation is altered by intensive grazing. Livestock graze selectively and constantly seek the more palatable and nutritious plants. Plants respond to grazing in one of three ways: they decrease, increase, or invade. Decreaser and increaser plants are climax plants. Generally, *decreasers* are the most heavily grazed and, consequently, the first to be injured by overgrazing. *Increasers* withstand grazing and replace the decreasers. *Invaders* are weeds that become established after the climax vegetation has been reduced by grazing.

Range condition is expressed in four condition classes to show the present condition of the vegetation on a range site in relation to the vegetation that grew on it originally. The condition is *excellent* if 76 to 100 percent of the vegetation is climax, *good* if 51 to 75 percent is climax, *fair* if 26 to 50 percent is climax, and *poor* if 0 to 25 percent is climax.

Descriptions of range sites

The range sites in Douglas and Sarpy Counties are described in the paragraphs that follow. Included in each is a description of the landscape of each site, the dominant vegetation on the site in excellent condition, the dominant vegetation in poor range condition, and the total annual air-dry production in pounds per acre for years when the site is in excellent condition.

The names of the soil series represented in a range site are named, but this does not mean that all the soils of a given series are in that group. To find the names of all the soils in any given site, refer to the "Guide to Mapping Units" at the back of this publication.

WET LAND RANGE SITE

Only Wet alluvial land is in this site. It is nearly level, is on bottom land, and is frequently flooded. The water table, which is at the surface or within a depth of 2 feet, determines the kind of vegetation that grows on this site. The soil material ranges from fine textured to moderately coarse textured.

The climax vegetation is a mixture of such decreaser grasses as prairie cordgrass. This decreaser makes up at least 50 percent of the total plant cover. Other perennial grasses and forbs make up the rest. Sedge is the principal increaser. If the site is in poor range condition, the typical plant community consists of Kentucky bluegrass, red clover, redtop, dandelion, and sparse amounts of prairie cordgrass and members of the sedge family.

If the site is in excellent range condition, the total annual production ranges from 6,000 pounds, air-dry weight, per acre in unfavorable years to 7,000 pounds in favorable years.

SUBIRRIGATED RANGE SITE

This site consists of soils of the Alda, Gibbon, Lex, Platte, and Wann series and Sandy alluvial land. These are shallow to deep, nearly level and gently sloping, somewhat poorly drained soils on bottom land. The water table fluctuates between depths of 2 and 6 feet. The surface layer ranges from silty clay loam to fine sandy loam. The underlying material ranges from silty clay loam to mixed sand and gravel. The vegetation is influenced mainly by the moderately low water table.

The climax vegetation is a mixture of such decreaser grasses as big bluestem, little bluestem, indiangrass, switchgrass, prairie cordgrass, and Canada wildrye. These decreasers make up at least 80 percent of the total plant cover. Other perennial grasses and forbs make up the rest. Kentucky bluegrass, green muhly, and sedge are the principal increasers. If the site is in poor range condition, the typical plant community consists of Kentucky bluegrass,

[4] Prepared by PETER N. JENSEN, range conservationist, Soil Conservation Service.

redtop, dandelion, western ragweed, foxtail barley, and sparse amounts of sedge.

If the site is in excellent condition, the total annual production ranges from 5,000 pounds, air-dry weight, per acre in unfavorable years to 6,000 pounds in favorable years.

SILTY OVERFLOW RANGE SITE

This site consists of soils of the Eudora and Kennebec series, soils of the Albaton, Luton, and Wabash series that have a silt loam surface layer, and Silty alluvial land. These are deep, nearly level to moderately sloping, well-drained to poorly drained soils on bottom land where flooding is occasional to frequent. The surface layer is dominantly silt loam. The underlying material ranges from silt loam to silty clay. The vegetation on this site is influenced mainly by the moderate infiltration rate and the additional water from periodic flooding.

The climax vegetation is a mixture of such decreaser grasses as big bluestem, switchgrass, indiangrass, prairie cordgrass, little bluestem, porcupinegrass, and Canada wildrye. These decreasers make up at least 80 percent of the total plant cover. Other grasses and forbs make up the rest. Kentucky bluegrass, green muhly, and sedge are the principal increasers. If the site is in poor range condition, the typical plant community consists of Kentucky bluegrass, western ragweed, and members of the sedge family.

If the site is in excellent range condition, the total annual production ranges from 4,000 pounds, air-dry weight, per acre in unfavorable years to 5,500 pounds in favorable years.

CLAYEY OVERFLOW RANGE SITE

This site consists of soils of the Colo, Onawa, and Percival series and those of the Albaton, Luton, and Wabash series that have a silty clay loam or silty clay surface layer. These are deep, nearly level, somewhat poorly drained or poorly drained soils on bottom land. The surface layer is generally silty clay loam or silty clay; it is silt loam in areas of Colo soils. The underlying material ranges from loamy fine sand to silty clay. The vegetation on this site is influenced mainly by the slow infiltration rate and the additional moisture from periodic flooding.

The climax vegetation is a mixture of such decreaser grasses as big bluestem, switchgrass, indiangrass, little bluestem, prairie cordgrass, and Canada wildrye. These decreasers make up at least 65 percent of the total plant cover. Other grasses and forbs make up the rest. Kentucky bluegrass and sedge are the principal increasers. If the site is in poor range condition, the typical plant community consists of Kentucky bluegrass, western ragweed, and sedges.

If the site is in excellent range condition, the total annual production ranges from 2,500 pounds, air-dry weight, per acre in unfavorable years to 4,500 pounds in favorable years.

SILTY LOWLAND RANGE SITE

This site consists of soils of the Haynie series and those of the Kennnebec series that are not appreciably flooded. These are deep, nearly level, moderately well drained soils on bottom land. The water table is at a depth of 4 to 8 feet. The surface layer is light silty clay loam or silt loam, and the underlying material is silt loam. Vegetation on this site is influenced mainly by the moderately low water table and the medium and moderately fine texture of the soils.

The climax vegetation is a mixture of such decreaser grasses as big bluestem, indiangrass, switchgrass, little bluestem, porcupinegrass, and Canada wildrye. These decreasers make up at least 80 percent of the total plant cover. Other grasses and forbs make up the rest. Kentucky bluegrass, tall dropseed, green muhly, and sedge are the principal increasers. If the site is in poor range condition, the typical plant community consists of Kentucky bluegrass, western ragweed, and sedges.

If the site is in excellent range condition, the total annual production ranges from 3,500 pounds, air-dry weight, per acre in unfavorable years to 5,000 pounds in favorable years.

SANDY LOWLAND RANGE SITE

This site consists of soils of the Carr, Cass, Inavale, and Sarpy series. These are deep, nearly level to moderately sloping, well-drained to excessively drained soils on bottom land. The water table fluctuates between depths of 5 and 10 feet. The surface layer ranges from very fine sandy loam to fine sand, and the underlying material from fine sandy loam to fine sand. The vegetation on this site is influenced mainly by the moderately low water table and the mostly moderately coarse and coarse soil texture.

The climax vegetation is a mixture of such decreaser grasses as sand bluestem, indiangrass, switchgrass, porcupinegrass, and Canada wildrye. These decreasers make up at least 70 percent of the total plant cover. Perennial grasses, forbs, and shrubs make up the rest. Little bluestem, needle-and-thread, Scribner panicum, purple lovegrass, and sedge are the principal increasers. If the site is in poor range condition, the typical plant community consists of sand dropseed, sand paspalum, western ragweed, and Kentucky bluegrass.

If the site is in excellent range condition, the total annual production ranges from 3,500 pounds, air-dry weight, per acre in unfavorable years to 4,500 pounds in favorable years.

SALINE LOWLAND RANGE SITE

This site consists only of Slickspots. This land type is moderately to strongly affected by salinity or alkalinity. The deep, nearly level soil material is somewhat poorly drained. The surface layer is silt loam or silty clay loam, and the subsoil is silty clay. The saline-alkali soil condition mainly determines the vegetation on this site.

The climax vegetation is a mixture of such decreaser grasses as switchgrass, indiangrass, and Canada wildrye. These decreasers make up at least 40 percent of the total plant cover. Other perennial grasses and forbs make up the rest. Inland saltgrass, western wheatgrass, blue grama, and sedge are the principal increasers. If the site is in poor range condition, the typical plant community consists of inland saltgrass, blue grama, Kentucky bluegrass, and sedge.

If the site is in excellent condition, the total annual production ranges from 2,500 pounds, air-dry weight, per acre in unfavorable years to 4,000 pounds in favorable years.

SAVANNAH RANGE SITE

Only Rock land is in this site. It is very steep and is on bluffs and on banks of large drainageways. The landscape is mostly outcrops of bedrock or glacial till. Between the outcrops are shallow and moderately deep soils that range from silty clay to sandy loam. The rock outcrop and the

shallow, very steep soils mainly determine the vegetation on this site.

The climax vegetation is a mixture of such decreaser grasses as big bluestem, indiangrass, switchgrass, prairie dropseed, and Canada wildrye. These decreasers make up at least 40 percent of the total plant cover. Other perennial grasses, forbs, shrubs, and trees make up the rest. Little bluestem, side-oats grama, Kentucky bluegrass, Scribner panicum, sedge, and various shrubs and trees, such as bur oak, American elm, green ash, hackberry, roughleaf dogwood, smooth sumac, and buckbrush, are the principal increasers. If the site has been overused, the typical plant community consists almost entirely of shrubs and trees.

If the site is in excellent range condition, the total annual production ranges from 3,000 pounds, air-dry weight, per acre in unfavorable years to 4,000 pounds in favorable years.

SANDY RANGE SITE

This site consists only of Dickinson soils, 11 to 17 percent slopes. These are deep, somewhat excessively drained soils on uplands. The surface layer ranges from silt loam to loamy sand. The subsoil ranges from sandy loam to fine sand. The vegetation on this site is influenced mainly by the moderately rapid permeability of the soils.

The climax vegetation is a mixture of such decreaser grasses as sand bluestem, switchgrass, indiangrass, and porcupinegrass. These decreasers make up at least 55 percent of the total plant cover. Other perennial grasses and forbs make up the rest. Little bluestem, needle-and-thread, prairie sandreed, sand dropseed, and sedge are the principal increasers. If the site is in poor range condition, the typical plant community consists of blue grama, sand dropseed, Scribner panicum, western ragweed, and sedge.

If the site is in excellent range condition, the total annual production ranges from 2,500 pounds, air-dry weight, per acre in unfavorable years to 4,000 pounds in favorable years.

SILTY RANGE SITE

This site consists of soils of the Judson, Marshall, Monona, and Ponca series. These deep, nearly level to very steep soils are on foot slopes and uplands. They are well drained. The surface layer and subsoil range from silt loam to silty clay loam. The vegetation on this site is influenced mainly by the silty texture of the soils and good drainage.

The climax vegetation is a mixture of such decreaser grasses as big bluestem, little bluestem, indiangrass, switchgrass, and porcupinegrass. These decreasers make up at least 80 percent of the total plant cover. Other perennial grasses, forbs, and shrubs make up the rest. Side-oats grama, tall dropseed, Scribner panicum, purple lovegrass, and sedge are the principal increasers. If the site is in poor range condition, the typical plant community consists of sand dropseed, blue grama, Scribner panicum, and western ragweed.

If the site is in excellent range condition, the total annual production ranges from 3,000 pounds, air-dry weight, per acre in unfavorable years to 4,500 pounds in favorable years.

LIMY UPLAND RANGE SITE

This site consists of soils of the Ida and Steinauer series. These are deep, strongly sloping to very steep, well-drained soils on uplands. They have lime at or near the surface. The surface layer ranges from silt loam to clay loam. The underlying material ranges from silt loam to silty clay. The calcareous surface layer mainly determines the vegetation on this site.

The climax vegetation is a mixture of such decreaser grasses as little bluestem, big bluestem, switchgrass, indiangrass, and prairie dropseed. These decreasers make up at least 75 percent of the total plant cover. Other perennial grasses, forbs, and shrubs make up the rest. Side-oats grama, blue grama, Scribner panicum, and sedge are the principal increasers. If the site is in poor range condition, the typical plant community consists of blue grama, hairy grama, sand dropseed, Scribner panicum, Kentucky bluegrass, and western ragweed.

If the site is in excellent range condition, the total annual production ranges from 2,000 pounds, air-dry weight, per acre in unfavorable years to 3,500 pounds in favorable years.

THIN LOESS RANGE SITE

This site consists of Gullied land and Rough broken land, loess. Both are on bottom land and upland bluffs. Drainage is excessive in the very steep areas. The soil material is silt loam or silty clay loam. The vegetation on this site is influenced mainly by the steep slopes, very rapid runoff, and calcareous soil condition.

The climax vegetation is a mixture of such decreaser grasses as little bluestem, big bluestem, side-oats grama, switchgrass, and indiangrass. These decreasers make up at least 80 percent of the total plant cover. Other perennial grasses, forbs, and shrubs make up the rest. Western wheatgrass, hairy grama, blue grama, tall dropseed, Scribner panicum, needle-and-thread, and sedge are the principal increasers. If the site is in poor range condition, the typical plant community consists of Kentucky bluegrass, hairy grama, sand dropseed, tall dropseed, and Scribner panicum.

If the site is in excellent range condition, the total annual production ranges from 2,500 pounds, air-dry weight, per acre in unfavorable years to 3,500 pounds in favorable years.

Woodland and Windbreaks [5]

Native woodland in Douglas and Sarpy Counties is limited to fairly narrow strips along streams and rivers and on bluffs adjacent to the Elkhorn, Platte, and Missouri River Valleys. Much of this acreage could produce commercial quantities of timber, but its esthetic value and use for recreation and wildlife and for watershed protection are more important.

Cottonwood, elm, willow, and other trees that tolerate wetness grow on the bottom land. Trees on the bottom land have a greater growth potential than those on the bluffs, but the kinds of trees are of much lower commercial value.

On the bluffs, the woodland is bur oak, walnut, basswood, American elm, green ash, hackberry, shagbark hickory, Kentucky coffeetree, mulberry, ironwood, and hawthorn. Red oak is on the bluffs along the Platte and Missouri River Valleys.

Early settlers in Douglas and Sarpy Counties planted trees for protection, shade, and fenceposts. Throughout the years landowners have continued to plant trees to protect their buildings and livestock. Native trees and shrubs con-

[5] Prepared by JAMES W. CARR, JR., forester, Soil Conservation Service.

tribute a great deal to the natural beauty of the landscape. They also provide food and cover for wildlife.

Windbreaks are needed for farmstead, livestock, and soil protection. The landowner who plants a windbreak is well paid for his time and expense. Windbreaks reduce home-heating costs, control snow drifting, provide shelter for livestock, improve conditions for wildlife, and beautify the countryside.

Trees are not easily established in Douglas and Sarpy Counties. Observing basic rules of tree culture, however, results in a high degree of tree survival. Healthy seedlings of adapted species maintained in good condition and properly planted on a well-prepared site can survive and grow well. They require care after planting if they are to continue to survive.

Table 3 shows the expected height at 20 years of age of trees suitable for windbreaks in these counties. The soils of the two counties were grouped into windbreak suitability groups, according to characteristics that affect tree growth, and detailed tree measurements were taken on soils of the major windbreak suitability groups.

The ratings for vigor in table 3 are based on observations of relative vigor and general condition of the trees. A rating of *good* indicates that one or more of the following conditions generally apply: leaves or needles are normal in color and growth; small amounts of dead wood (top, branches, and twigs) occur within the live crown; and no disease, insect, and climatic damage is evident. A rating of *fair* indicates that one or more of the following conditions generally apply: leaves or needles are obviously abnormal in color and growth; substantial amounts of dead wood (top, branches, and twigs) are within the live crown; evidence of moderate disease, insect, or climatic damage is obvious; and current year's growth is obviously less than normal. The rating of *poor* indicates that one or more of the following conditions generally apply: leaves or needles are very abnormal in color and growth; very large amounts of dead wood (top, branches, and twigs) occur within the live crown; evidence of extensive disease, insect, and climatic damage is obvious; and current year's growth is essentially negligible.

The conifers, cedar and pine, are better suited to windbreaks than other species. Measurements show that eastern redcedar and species of pine are the most reliable windbreak species. Both rated high in survival and vigor in the studies made. They hold their leaves through the winter and give maximum protection when it is most needed.

Table 3 also shows several broadleaf trees that are well suited to windbreaks. The best trees, according to the results of the study, are green ash, honeylocust, and hackberry. The best shrubs are lilac, cotoneaster, honeysuckle, American plum, and chokecherry. The windbreak study shows that eastern redcedar can be expected to grow about 1 foot in height per year and can reach mature heights of 30 to 40 feet. Pine and broadleaf trees generally grow faster than redcedar and are somewhat taller.

Rate of growth in a windbreak varies with soil moisture conditions, soil fertility, exposure, and arrangement of trees within the planting. Some species grow faster than others, and some make an early fast growth, but tend to die young. This is sometimes true of cottonwood, Siberian elm, and Russian-olive, which are early, vigorous growers. They can, however, spread where they are not wanted and can be short lived. Boxelder and mulberry commonly freeze back during severe winters, and green ash is susceptible to damage by borers.

A good windbreak should be designed to fit the soils in which it is to grow. The intended purpose of the planting should be considered. Specific information on design, establishment, and care of the windbreak is available from the Soil Conservation Service and the Extension Service.

Descriptions of windbreak suitability groups

The windbreak suitability groups recognized in Douglas and Sarpy Counties are described in the paragraphs that follow. The soils in each group are identified by series name, but this does not mean that all the soils of a given series are in the group. To find the names of all the soils in a group, refer to the "Guide to Mapping Units" at the back of the survey.

The soils in each group produce similar tree growth and survival under normal conditions of weather and care. Trees and shrubs suitable for windbreak plantings are identified for each group.

SILTY TO CLAYEY WINDBREAK SUITABILITY GROUP

In this group are soils of the Eudora, Haynie, Ida, Judson, Marshall, Monona, and Ponca series and the Cass soils that have a very fine sandy loam surface layer. These are deep, nearly level to moderately steep soils on uplands, colluvial slopes, and bottom land.

These soils are well drained. Some are eroded. The surface layer is medium textured to moderately fine textured, and the subsoil and underlying material are medium textured to fine textured. The available water capacity ranges from moderate to high, and the organic-matter content from low to high.

These soils generally provide good tree planting sites. Good survival and growth of adapted species can be expected. Drought and the moisture competition from weeds and grasses are the principal hazards. Water erosion is a hazard in the gently sloping to moderately steep areas.

Conifers suitable for planting are eastern redcedar ponderosa pine, Austrian pine, Scotch pine, white pine, Colorado blue spruce, and Norway spruce. Suitable low broadleaf trees are Russian mulberry and Russian-olive. Suitable tall broadleaf trees are hackberry, green ash, honeylocust, bur oak, and red oak. Suitable shrubs are cotoneaster, honeysuckle, lilac, chokecherry, skunkbush sumac, autumn-olive, and Amur maple.

SANDY WINDBREAK SUITABILITY GROUP

In this group are soils of the Carr, Cass, and Dickinson series and those Inavale soils that are not hummocky. These are deep soils on bottom land and uplands.

These soils are moderately well drained, well drained, or somewhat excessively drained. The surface layer and subsoil are moderately coarse textured to coarse textured. The available water capacity is low in the Inavale soils and high to moderate in the rest. Organic-matter content ranges from moderate to low.

These soils are suited to tree planting if strips of sod or other plant cover can be maintained between the rows to control soil blowing. Cultivation generally should be restricted to the tree rows. Drought and the moisture competition from grasses and weeds are hazards. Water erosion can be a hazard in some sloping areas.

534-869 O - 75 - 4

TABLE 3.—*Relative vigor and estimated height, by windbreak*

[Very Wet, Moderately Saline or Alkali, and Undesirable windbreak suitability

Windbreak suitability group	Eastern redcedar		Ponderosa pine		Green ash	
	Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height
		Ft.		*Ft.*		*Ft.*
Silty to Clayey	Good	24	Good	28	Good	25
Sandy	Good	23	Good	31	Fair	29
Very Sandy	Good	18	Good	26	Fair	23
Moderately Wet	Good	23	Poor	(1)	Fair	29

[1] Not applicable because most trees are dead or dying.

Conifers suitable for planting are eastern redcedar, ponderosa pine, Scotch pine, Austrian pine, and white pine. Suitable low broadleaf trees are Russian mulberry and boxelder. Suitable tall broadleaf trees are honeylocust, green ash, and hackberry. Suitable shrubs are honeysuckle, skunkbush sumac, autumn-olive, lilac, and American plum.

VERY SANDY WINDBREAK SUITABILITY GROUP

In this group are soils of the Sarpy series and the Inavale soils that have a hummocky surface. These are deep, nearly level or hummocky soils on bottom land.

These soils are somewhat excessively drained to excessively drained. Depth to the seasonal high water table ranges from 5 to 10 feet. The surface layer and underlying material are coarse textured. The available water capacity and organic-matter content are low.

These soils are so loose that trees should be planted in shallow furrows and not cultivated. Young trees are damaged during high winds and can be covered with drifting sand.

Conifers suitable for planting are eastern redcedar, ponderosa pine, Scotch pine, and Austrian pine.

MODERATELY WET WINDBREAK SUITABILITY GROUP

In this group are soils of the Albaton, Alda, Colo, Gibbon, Kennebec, Lex, Luton, Onawa, Percival, Platte, Wabash, and Wann series. All are on bottom land. Alda and Lex soils are moderately deep; Platte soils are shallow; and the rest are deep.

These soils are moderately well drained to poorly drained. Occasionally they are flooded. The water table fluctuates between depths of 2 and 10 feet. The surface layer and subsoil range from fine textured to moderately coarse textured, and the underlying material from fine textured to coarse textured. The available water capacity and organic-matter content range from low to high.

These soils are well suited to tree plantings that tolerate occasional wetness. Establishing plantings is difficult during wet periods. Cultivating between the rows is difficult because the competing herbaceous vegetation is abundant and persistent.

Conifers suitable for planting are eastern redcedar, Scotch pine, Austrian pine, and Black Hills spruce. Low broadleaf trees suitable for planting are Russian mulberry and diamond willow. Suitable tall broadleaf trees are honeylocust, green ash, hackberry, black walnut, cottonwood, golden willow, white willow, and sycamore. Suitable shrubs are redosier dogwood, buffaloberry, eastern chokecherry, and purple willow.

MODERATELY SALINE OR ALKALI WINDBREAK SUITABILITY GROUP

Gibbon-Slickspots complex, the only mapping unit in this group, consists of deep soils on bottom land.

The soils are somewhat poorly drained. The water table is at a depth of 2 to 6 feet. The surface layer is medium textured to moderately coarse textured, and the underlying material is fine textured. Salts and alkali accumulate in areas of Slickspots. Alkalinity is moderate to strong.

The soils are suited to trees that tolerate moderate concentrations of salts or alkali. Establishing trees is difficult during wet periods. Wetness makes cultivation between the rows difficult.

Conifers suitable for planting are eastern redcedar and Australian pine. Suitable tall broadleaf trees are green ash, honeylocust, and cottonwood. A suitable low broadleaf tree is Russian-olive. Suitable shrubs are buffaloberry and skunkbush sumac.

UNDESIRABLE WINDBREAK SUITABILITY GROUP

In this group are Gullied land, Pits and dumps, Riverwash, Rock land, Rough broken land, loess, Sandy alluvial land, Silty alluvial land, Wet alluvial land, Monona and Ida soils that have slopes of more than 17 percent, and soils of the Steinauer series. The soil material ranges from deep to very shallow.

The soils and land types in this group range widely in their characteristics. The soils are very poorly drained to excessively drained and are nearly level to very steep. The soil material ranges from moderately fine textured to coarse textured in the surface layer and underlying material. Some areas have a high water table, and some are frequently flooded.

The soils of this group are not generally suited to windbreak plantings of any kind. If hand planted or planted by other special approved practices, plantings of tolerant tree and shrub species can be established in some areas used for recreation and wildlife.

suitability groups, of specified trees at 20 years of age

groups are not included because the need for windbreaks is uncommon]

Hackberry		Honeylocust		Russian-olive		Russian mulberry		Cottonwood	
Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height
	Ft.		*Ft.*		*Ft.*		*Ft.*		*Ft.*
Good	26	Fair	33	Fair	21	Fair	24	Poor	(1)
Fair	28	Fair	31	Fair	27	Fair	21	Fair	60
Fair	16	Fair	16	Fair	17	Fair	17	Fair	45
(2)	(2)	Fair	35	Poor	(1)	Fair	12	Fair	54

[2] Insufficient data available.

Selection of Plants for Environmental Plantings [6]

Many plants are grown to provide attractive and satisfying places to live, work, and play. Trees, grasses, shrubs, or other plants are used to control erosion, reduce sediment, provide shade along streets and in parks, beautify lawns and homes, provide privacy, reduce noise, or landscape open space around factories, apartment houses, and school buildings.

Table 4, intended as a general guide, suggests species of plants suitable for environmental plantings on the soils of Douglas and Sarpy Counties. The soils are grouped according to the soil features or properties that limit the adaptation and use of a plant.

Color of foliage, flowering and fruiting characteristics, growth habits, and susceptibility to disease have been considered in preparing table 4. Many horticultural varieties of plants that are well adapted to the climate of Douglas and Sarpy Counties are not named in the table. Information on horticultural varieties is generally available from local nurserymen.

American elm, which is suited to many different soils and was formerly used extensively as a shade tree, is not listed in table 4 because it is susceptible to Dutch elm disease.

Growth habits, shade tolerance, erosion control value, and esthetic features determine the suitability and use of plants for various purposes and in various locations. Most plants can accomplish more than one purpose if suitable plants are selected. For example, some plants that have colorful foliage or fruit can be as useful for wildlife food and cover as they are for hedges, screens, erosion control, or beautification of the landscape.

Wildlife and Recreation [7]

The wildlife population is determined largely by the kind and amount of vegetation the soil is capable of producing. Adequate habitat, along with food and water, is the key to wildlife abundance.

Landscape plays a major role in determining wildlife numbers, as do soil characteristics, such as fertility. Fertile soils support wildlife in greater numbers and of better quality, both game and nongame species. Mainly game species are described here, but nongame species are becoming increasingly important.

Bird watching and an appreciation of nature are now important in helping man understand his relationship with the total environment. Wildlife is gaining a greater monetary value as a part of our total environment.

Wildlife species have been used in the past to evaluate the quality of the environment. Canary birds, for example, have a low tolerance for lethal gas and have been used as indicators of air quality in mines. Other species of wildlife also can act as a barometer of the atmosphere. A livable environment for wildlife is generally a quality environment for man.

Fertile soils cause pelts of furbearing species, such as mink, muskrat, weasel, and beaver, to be of better quality and game birds and animals to be larger, more palatable, and more nutritious.

In many areas the soils that have the highest potential for wildlife do not have the highest wildlife populations. Areas subject to hunting pressure, clean tillage, and improved harvesting methods do not attract wildlife. The potential remains, however, and wildlife values can be enhanced with little cost and effort. Wildlife has a place in both rural and urban settings and should be considered in planning optimum use of these areas.

Fishponds filled by runoff from fertile fields generally produce more pounds of fish than average because such runoff increases the food supply. Zooplankton and phytoplankton, microscopic animals and plants produced in fertile ponds, provide food for larger aquatic animals, such as frogs. Frogs, in turn, provide food for fish.

Steep slopes and a rough, irregular landscape are hazards to livestock and are poorly suited to crop production. In these areas, the natural undisturbed landscape can be used as cover and food supply for wildlife. In many areas where plant cover is lacking, habitat can be developed by planting trees and shrubs that flower and bear fruit. Some

[6] This section was prepared by JAMES W. CARR, JR., forester, and E. O. PETERSON, agronomist, Soil Conservation Service.

[7] Prepared by ROBERT O. KOERNER, wildlife biologist, Soil Conservation Service.

TABLE 4.—*Environmental*

Soil groups, series, and map symbols	Trees suitable for—			
	Shade	Ornamentals	Street borders	Critical areas
Group I: No limitation if plants are climatically adapted. Carr: Ca Cass: Cc, Cd, Ce Dickinson: DcE Eudora: Ed Ida: IdD2, IdE, IdE2 Judson: JuB Marshall: MaA, MaB, MaC, MaC2, MaD, MeD2, MfE, MfE2 Monona: MoA, MoB, MoC, MoC2, MoD, MoD2, MoE, MsE2, MsF2 Ponca: PdD2, PdE2	Sugar maple, scarlet oak, silver maple, red oak, white oak, bur oak, hackberry, green ash, sycamore, American linden, walnut.	Mountainash, paper birch, pin oak, Kentucky coffeetree, ginkgo, goldenrain-tree, Austrian pine, white pine, Scotch pine, blue spruce, Norway spruce, magnolia, flowering crabapple, linden, black cherry, concolor fir, redbud.	Pin oak, thornless honeylocust, basswood, Norway maple, ironwood, littleleaf linden, hackberry.	Roughleaf dogwood, smooth sumac, autumn-olive, arnot bristly locust, periwinkle, dwarf polygonum, wintercreeper euonymus, spreading juniper.
Group II: Choice of plants is limited because the soil is fine textured and runoff is rapid or very rapid. Monona: MsG Steinauer: StE2	Bur oak, red oak, scarlet oak.	Austrian pine, Scotch pine, juniper, Russian-olive.	Thornless honeylocust, hackberry, green ash, ironwood.	Smooth sumac, roughleaf dogwood, autumn-olive, arnot bristly locust, spreading juniper.
Group III: Choice of plants is limited because soils are sandy, droughty, and low in fertility. Inavale: Im, In Sarpy: Sp	Silver maple, cottonwood, sycamore, scarlet oak.	Austrian pine, Scotch pine, ponderosa pine, white pine.	Thornless honeylocust, hackberry.	Autumn-olive, arnot bristly locust, spreading juniper.
Group IV: Wetness limits the choice of plants. Albaton: Ab, Ac Alda: Af, Ag Colo: Cg, Ck Gibbon: Ga, Gb, Gc Kennebec: Ko Lex: Le Luton: Ls, Lt, Lu Onawa: On Percival: Pa Platte: Pc Sandy alluvial land: Sd Silty alluvial land: Ss Wabash: Wb, Wc Wann: Wm	Cottonwood, green ash, hackberry, sycamore, American linden, silver maple, red maple, swamp white oak, weeping willow, walnut.	Pin oak, paper birch, catalpa, mountainash, Scotch pine, Black Hills spruce, Kentucky coffeetree, eastern hemlock, Austrian pine, baldcypress.	Thornless honeylocust, littleleaf linden, redmond linden, pin oak.	Redosier dogwood, roughleaf dogwood, autumn-olive, chokecherry, American plum.
Group V: Choice of plants is limited because soils are affected by saline or alkaline salts. Gibbon: Gs	Weeping willow, green ash, boxelder, white poplar, peachleaf willow, cottonwood.	Crabapple, Russian-olive, corkscrew willow, Rocky Mountain juniper, Austrian pine, eastern redcedar, pussy willow.	Green ash, hybrid elm, thornless honeylocust.	Black locust, redosier dogwood.
Group VI: Choice of plants is severely limited and onsite investigation is required. Gullied land: Gu Pits and dumps: Po Riverwash: Ra Rock land: Rk Rough broken land, loess: Rn Wet alluvial land: Wt	None	None	None	None

planting guide

Trees and shrubs suitable for—			Grasses suitable for—		
Wildlife food and cover	Hedges	Screens	Lawns	Roadsides, steep banks	Recreation areas
Autumn-olive, honeysuckle, American bittersweet, Nanking cherry, highbush cranberry, crabapple, Austrian pine, winterberry *euonymus*, Washington hawthorn, Amur maple, skunkbush sumac, eastern redcedar, chokecherry, snowberry.	Honeysuckle, cotoneaster, lilac, winged euonymus, privet, eastern hemlock, viburnum.	Eastern redcedar, autumn-olive, honeysuckle, lilac, Austrian pine, Scotch pine, ponderosa pine, white pine, Norway spruce, Amur maple, eastern hemlock, upright juniper, Oriental arborvitae, Lombardy poplar.	Kentucky bluegrass, perennial ryegrass.	Little bluestem, big bluestem, switchgrass, side-oats grama, blue grama, bromegrass, perennial ryegrass, crownvetch (a legume).	Blue grama, buffalograss, tall fescue, Kentucky bluegrass, creeping red fescue, perennial ryegrass.
Autumn-olive, crabapple, skunkbush, sumac, eastern redcedar, American plum, Russian-olive.	Autumn-olive, honeysuckle, cotoneaster, lilac, Siberian peashrub, Amur maple.	Eastern redcedar, autumn-olive, Austrian pine, Scotch pine, ponderosa pine, upright juniper, Russian-olive.	Blue grama, buffalograss, Kentucky bluegrass.	Little bluestem, big bluestem, switchgrass, crownvetch (a legume).	Blue grama, buffalograss, side-oats grama.
Autumn-olive, Austrian pine, American plum, eastern redcedar, ponderosa pine, Scotch pine, white pine.	Lilac, cotoneaster.	Eastern redcedar, Rocky Mountain juniper, Austrian pine, ponderosa pine, Scotch pine, autumn-olive, lilac, chokecherry.	Blue grama	Little bluestem, big bluestem, switchgrass.	Blue grama, western wheatgrass, tall fescue.
Redosier dogwood, autumn-olive, eastern redcedar, oriental arborvitae, Scotch pine, buffaloberry, American elderberry, Virginia creeper, Austrian pine.	Redosier dogwood, Amur maple, autumn-olive.	Eastern redcedar, Scotch pine, Austrian pine, autumn-olive, Lombardy poplar, oriental arborvitae, buffaloberry, bolleana poplar.	Kentucky bluegrass.	Reed canarygrass, switchgrass.	Tall fescue.
Russian-olive, golden current, redosier dogwood, buffaloberry, honeysuckle.	Redosier dogwood.	Eastern redcedar, Austrian pine, Russian-olive, bolleana poplar, buffaloberry.	None	Switchgrass, western wheatgrass.	Tall fescue, western wheatgrass.
None	None	None	None	Switchgrass, little bluestem.	None.

of the adapted species are oak, red mulberry, redbud, elderberry, honeysuckle, Russian-olive, and chokeberry. Suitable grasses or legumes are partridgepea, vetch, red clover, big bluestem, little bluestem, and switchgrass.

Wetness, permeability, and available water capacity are important soil characteristics to be considered in selecting pond sites for wildlife and recreation. In Douglas and Sarpy Counties, ponds are commonly subject to seepage and therefore are unsatisfactory. The Missouri and Platte Rivers provide fishing for food and sport. Catfish, bullhead, and sauger are the main species. Farm ponds, if properly stocked and managed, furnish warmwater fishing. Some small streams that have adjacent backwater areas support limited populations of largemouth bass and crappie.

The principal soils in Douglas and Sarpy Counties were evaluated for wildlife potential based on the soil associations shown on the general soil map. These soil associations are related to present land use and types of vegetation and, hence, to certain wildlife species.

Farms in the Cass-Inavale-Wann association are diversified and consist mainly of combination cash-grain and livestock. Some cultivated areas are used for corn and soybeans. Areas of mixed grass and trees are used for wildlife, as well as for grazing and recreation. Many gravel pits along the Platte River offer opportunities for raising bait fish. Deer population density is moderate, four to nine per square mile. The ring-necked pheasant population density is low, about 10 to 50 per square mile. Bobwhite quail density is also low, 10 to 100 per square mile, and is mainly near wooded areas. Waterfowl and other species of wetland wildlife are along the Platte and Elkhorn Rivers. Migrating waterfowl use the rivers in fall and spring.

The Gibbon-Wabash association is on the nearby level bottom land between the Elkhorn and Platte Rivers. Corn, small grain, and alfalfa are the main cultivated crops, and and these provide food for openland wildlife. Deer populations are highest along the rivers. Deer use the open fields as a source of food. The population density of pheasant and bobwhite quail is low, but the potential is high if habitat is managed properly.

The Ponca-Ida association consists of the steep and very steep soils on bluffs adjacent to the Elkhorn River Valley. It is dissected by many brushy drainageways and gullies that provide cover and travel lanes for many wildlife species. The smaller cultivated fields adjacent to waterways and wooded draws provided food for wildlife. Water is provided by the intermittent streams and draws. Fields of sunflowers, an excellent crop for wildlife, are used as side benefits along with other small grain and corn. Many species of woody and herbaceous plants, such as black walnut, hickory, hackberry, ash, Kentucky coffeetree, linden, maple, and dogwood, are in this association. Bur oak and cedar grow on the slopes and ridgetops. Common shrubs are elderberry, western snowberry, and gooseberry. Grasses include big bluestem, little bluestem, switchgrass, smooth brome, and annual foxtail. Prairie coneflower, lupine, and beebalm are common wildflowers.

The Marshall-Ponca association is mainly on uplands that are cultivated. The main crops are corn, small grain, grain sorghum, and alfalfa. Soil-conserving practices, such as terraces and waterways, along with stripcropping, increase the edges or borders between crops. This benefits wildlife by creating variety in kinds of vegetation. Deer population in this area is low, averaging less than one per square mile. Pheasant and bobwhite quail populations are also low, but the potential is high if better habitat is created. Woody plant species that benefit wildlife are red mulberry, green ash, honeylocust, bur oak, and pin oak.

In the Monona-Ida association are nearly level to steep soils on bluffs adjacent to the Missouri River Valley. Wildlife types and population densities are similar to those on the Ponca-Ida association. Red oak grows in addition to other species. Fontenelle Forest, near Bellevue in Sarpy County, is part of this association. This is an undisturbed natural area of approximately 1,500 acres. In 1970, the forest was declared to be a national historical landmark. Forest trails were included in the National Recreational Trail System, the only area in Nebraska so designated to date. In July 1972, the forest was dedicated as a National Environmental Education Landmark. This area has significant wildlife value. It gives teachers, students, and residents of Bellevue, Omaha, and surrounding communities and States an opportunity to see undisturbed wildlife habitat. Fontenelle Forest contains wooded bluffs and ravines, flood plain, swamp, marsh, prairie, and an oxbow lake. These afford woodland, openland, and wetland wildlife ecosystems. It is a haven for the amateur wildlife enthusiast as well as the professional to study in detail all the flora and fauna of the area. In the flat area adjacent to the forest, other types of vegetation, such as field crops and grass, are available for openland wildlife species. Eight Merrimam's wild turkey, two males and six females, were released in 1964 at Fontenelle.

The Albaton-Haynie association is on bottom land along the Missouri River. Deer are abundant in the wooded areas. The bottom land provides food, the river provides water, and the woodland provides food and cover for wildlife.

All of the foregoing factors were considered in preparing table 5, which shows the potential for the enhancement of wildlife value in Douglas and Sarpy Counties.

As shown in table 5, Douglas and Sarpy Counties have three main classes of wildlife. These classes are defined as follows:

Openland wildlife is defined as those birds and mammals that normally make their homes in cropland, pasture, meadow, lawn, and areas overgrown with grasses, herbs, and shrubby plants. Examples are ring-necked pheasant, bobwhite quail, dove, songbirds, cottontail rabbit, red fox, and coyote.

Woodland wildlife is defined as those birds and mammals that normally make their homes in areas wooded with hardwood trees and shrubs, coniferous trees and shrubs, or mixtures of such plants. Examples are wild turkey, fox squirrel, gray squirrel, white-tailed deer, raccoon, and opossum.

Wetland wildlife is defined as those birds and mammals that normally make their homes in wet areas, such as ponds, marshes, and swamps. Examples are ducks, geese, herons, shore birds, mink, muskrat, and beaver.

Developing good habitat for wildlife requires the proper location and distribution of vegetation. Technical assistance in planning wildlife developments and determining the kind of vegetation can be obtained at the local offices of the Soil Conservation Service in Elkhorn or Papillion, Nebraska. Additional information and assistance can be obtained from Nebraska Game and Parks Commission, the

TABLE 5. *Potential of the principal soils in soil associations for producing elements of wildlife habitat and kinds of wildlife*

Soil associations	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees and shrubs	Coniferous plants	Wetland food and cover	Shallow water development	Openland wildlife	Woodland wildlife	Wetland wildlife
1. Cass-Inavale-Wann association:										
Cass soil	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Inavale soil	Fair	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor.
Wann soil	Good	Good	Good	Good for cottonwood and willow.	Fair	Fair	Fair	Good	Fair	Fair.
2. Gibbon-Eudora-Wabash association:										
Gibbon soil	Good	Good	Good	Good	Fair	Poor	Poor	Good	Fair	Poor.
Wabash soil	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair.
3. Ponca-Ida association:										
Ponca soil	Good	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor.
Ida soil, 5 to 17 percent slopes.	Fair	Fair	Fair	Fair	Good	Very poor	Very poor	Fair	Good	Very poor.
Ida soil, over 17 percent slopes.	Very poor	Poor	Poor	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor.
4. Marshall-Ponca association:										
Marshall soil	Good	Good	Good	Good	Good	Very poor	Very poor	Good	Fair	Very poor.
Ponca soil	Good	Good	Good	Good	Good	Very poor	Very poor	Good	Fair	Very poor.
5. Monona-Ida association:										
Monona soil	Fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor.
Ida soil, 5 to 17 percent slopes.	Fair	Fair	Fair	Fair	Good	Very poor	Very poor	Fair	Good	Very poor.
Ida soil, over 17 percent slopes.	Very poor	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor.
6. Albaton-Haynie association:										
Albaton soil	Fair	Fair	Good	Fair	Poor	Fair	Fair	Good	Fair	Fair.
Haynie soil	Good	Good	Good	Good	Fair	Poor	Poor	Good	Fair	Poor.

Bureau of Sport Fisheries and Wildlife, and from the Federal Extension Service. The Soil Conservation Service also provides technical assistance in planning and developing outdoor recreational facilities.

Engineering Uses of the Soils [8]

This section is useful to those who need information about soils used as structural material or as foundations upon which structures are built. Among those who benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, to predict performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 6, 7, and 8. These tables show, respectively, results of engineering laboratory tests on soil samples, estimates of soil properties significant in engineering, and interpretations for various engineering uses.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 7 and 8, and it also can be used to make other useful maps.

This information, however, does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially small ones, is needed because many delineated areas of a given mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for engineering.

[8] F. STEWART BOHRER, engineer, Soil Conservation Service, helped prepare this section.

Some of the terms used in this soil survey have a special meaning in soil science that may not be familiar to engineers. The Glossary defines many of these terms commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system, used by SCS engineers, the Department of Defense, and others, and the AASHO system adopted by the American Association of State Highway Officials.

The Unified system (*7*) is used to classify soils according to engineering uses for building material or for the support of structures other than highways. Soils are classified according to particle-size distribution, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes. The eight classes of coarse-grained soils are subdivided on the basis of gravel and sand content and are identified as GW, GP, GM, GC, SW, SP, SM, and SC. The six classes of fine-grained soils are subdivided on the basis of the plasticity index; nonplastic classes are ML, MH, OL, and OH, and plastic classes are CL and CH. There is one class of highly organic soils, Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example ML–CL.

The AASHO system (*1*) is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is classified in one of seven basic groups that range from A–1 through A–7 on the basis of grain-size distribution, liquid limit. and plasticity index. In group A–1 are soils of high bearing strength, or the best soils for subgrade (foundation). In group A–7 are soils that have low strength when wet and that are the poorest soils for subgrade. If laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHO classification for tested soils, with group index numbers in parentheses, is shown in table 6; the estimated classification, without group index numbers, is given in table 7 for all soils mapped in the survey area.

USDA texture (*4*) is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. Stony, cobbly, and gravelly are used as textural modifiers as needed.

Engineering test data

Table 6 contains engineering test data for some of the major soil series in Douglas and Sarpy Counties. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limit and plastic limit. The mechanical analyses were made by combined sieve and hydrometer methods. Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material.

Soil properties significant in engineering

Soil properties significant in engineering are estimated in table 7. These estimates are based on the different layers of a representative soil profile having significantly different soil properties. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 7.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Liquid limit and plasticity index are measurements of water content obtained by specified operations. As the water content of a clayey soil, from which the particles coarser than 0.5 millimeter have been removed, is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of water content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 7, but in table 6 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is an estimate of the rate at which saturated soil transmits water in a vertical direction under a unit head of pressure. It is estimated on the basis of those soil characteristics observed in the field, particularly structure, porosity, and texture. Lateral seepage or such transient soil features as plowpans and surface crusts are not considered.

Available water capacity is an estimate of the capacity of soils to hold water for use by most plants. It is defined here as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction refers to the acidity or alkalinity of a soil, expressed in pH values, for a stated soil-solution mixture. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential refers to the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells as it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils damages building foundations, roads, and other structures in places. Soils having a high shrink-swell potential are the most hazardous. Shrink-swell potential is not indicated for organic soils or certain soils that shrink markedly on drying but do not swell quickly when rewetted.

Engineering interpretations

Interpretations in table 8 are based on the engineering properties of soils shown in table 7, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Douglas and Sarpy Counties. In table 8, ratings are used to summarize limitation or suitability of the soils for all listed purposes except drainage of cropland and pasture, irrigation, ponds and reservoirs, embankments, and terraces and diversions. For these particular uses, table 8 lists those soil features not to be overlooked in the planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means that soil properties are generally favorable for the rated use, or, in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation, special designs, or intensive maintenance is needed. For some uses, the rating of severe is divided to obtain ratings of severe and very severe. *Very severe* means that one or more soil properties are so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly not practical for the rated use.

Soil suitability is rated good, fair, and poor, which are, respectively, approximately parallel in meaning to the terms slight, moderate, and severe.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. It is assumed that the embankment is compacted to medium density and the pond is protected from flooding. Properties that affect the pond floor are permeability, organic-matter content, and slope. If the floor requires leveling, depth to bedrock is important. Properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the number of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet; for example, excavations for pipelines, sewer lines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or large stones, and freedom from flooding or a high water table.

Dwellings, as rated in table 8, are no more than three stories high and are supported by foundation footings placed in undisturbed soil. The rating is based on the capacity of the soil to support load and resist settlement under load and the ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

TABLE 6.—*Engineering*

[Tests performed by the Nebraska Department of Roads, in accordance with

Soil name and location	Parent material	Nebraska report number S67—	Depth	Specific gravity
			In.	
Cass fine sandy loam, loamy substratum: 0.3 mile west and 0.2 mile north of southeast corner, sec. 10, T. 16 N., R. 9 E. (Finer textured to a depth of 16 inches than modal profile.)	Loamy alluvium.	555 556 557	0–6 10–16 16–26	2. 58 2. 62 2. 65
Eudora silt loam: 0.4 mile south and 120 feet west of northeast corner, sec. 9, T. 16 N., R. 9 E. (Modal profile.)	Silty alluvium.	550 551 552	0–7 13–32 32–58	2. 59 2. 62 2. 62
Gibbon silt loam: 0.4 mile west and 60 feet south of northeast corner, sec. 24, T. 16 N., R. 9 E. (Modal profile.)	Silty alluvium.	529 530 531	0–7 16–25 25–40	2. 63 2. 65 2. 65
Ida silt loam: 0.2 mile east and 20 feet south of northwest corner, sec. 12, T. 16 N., R. 12 E. (Modal profile.)	Peoria loess.	553 554	0–5 11–52	2. 67 2. 67
Inavale loamy fine sand: 50 feet south and 50 feet east of northwest corner, sec. 35, T. 16 N., R. 9 E. (Modal profile.)	Sandy alluvium.	538 539 540	0–6 6–11 11–28	2. 63 2. 63 2. 65
Judson silt loam: 0.25 mile west and 150 feet south of northeast corner, sec. 33, T. 16 N., R. 11 E. (Modal profile.)	Silty colluvium.	541 542 543	0–7 26–37 37–48	2. 60 2. 62 2. 67
Kennebec silt loam: 0.2 mile north and 2,590 feet east of southwest corner, sec. 24, T. 16 N., R. 11 E. (Modal profile.)	Silty alluvium.	532 533 534	0–7 17–26 26–42	2. 63 2. 60 2. 63
Marshall silty clay loam: 0.1 mile west and 228 feet south of northeast corner, sec. 20, T. 16 N., R. 11 E. (Modal profile.)	Peoria loess.	526 527 528	0–6 15–26 39–60	2. 58 2. 66 2. 66
Monona silt loam: 0.3 mile south and 0.25 mile east of northwest corner, sec. 12, T. 16 N., R. 12 E. (Modal profile.)	Peoria loess.	523 524 525	0–7 15–21 30–48	2. 65 2. 69 2. 67
Wabash silty clay: 0.4 mile south and 100 feet west of northeast corner, sec. 6, T. 16 N., R. 10 E. (Modal profile.)	Clayey alluvium.	547 548 549	0–7 11–21 21–31	2. 63 2. 62 2. 69

[1] Mechanical analysis according to the American Association of State Highway Officials Designation T88–47 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analysed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the

test data

standard procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [1]								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than—						AASHO [2]	Unified
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
								Pct.			
100	98	90	55	40	17	8	6	[3] NP	NP	A-4(4)	ML
----------	100	95	60	42	12	6	5	NP	NP	A-4(5)	ML
100	99	95	44	24	3	2	2	NP	NP	A-4(2)	SM
100	99	98	85	70	18	9	7	NP	NP	A-4(8)	ML
----------	--------	100	91	82	15	6	5	NP	NP	A-4(8)	ML
----------	--------	100	96	84	22	4	2	NP	NP	A-4(8)	ML
----------	--------	100	95	80	31	14	11	32	6	A-4(8)	ML
100	99	98	93	79	30	16	14	32	7	A-4(8)	ML-CL
100	99	99	92	72	21	11	9	26	1	A-4(8)	ML
----------	--------	--------	100	90	57	27	23	41	17	A-7-6(11)	ML-CL
----------	--------	--------	100	91	55	24	16	38	15	A-6(10)	ML-CL
100	95	81	17	9	4	2	2	NP	NP	A-2-4(0)	SM
100	95	82	18	9	4	2	1	NP	NP	A-2-4(0)	SM
100	96	84	12	9	4	1	1	NP	NP	A-2-4(0)	SW-SM
----------	100	99	99	90	51	31	19	40	14	A-6(10)	ML-CL
----------	--------	100	99	89	52	29	20	42	14	A-7-6(10)	ML
----------	100	99	99	93	53	34	23	42	18	A-7-6(10)	ML-CL
----------	--------	100	99	91	57	32	26	39	13	A-6(9)	ML-CL
----------	--------	100	99	94	63	31	23	46	19	A-7-6(13)	ML-CL
----------	--------	100	99	94	53	30	24	44	20	A-7-6(13)	CL
----------	--------	--------	100	90	53	29	23	34	10	A-4(8)	ML-CL
----------	--------	100	99	95	61	36	30	46	22	A-7-6(14)	CL
----------	--------	--------	100	89	55	30	25	39	15	A-6(10)	ML-CL
----------	--------	--------	100	92	68	29	23	36	11	A-6(8)	ML-CL
----------	--------	--------	100	89	57	29	23	40	20	A-6(12)	CL
----------	--------	--------	100	90	56	22	21	38	15	A-6(10)	ML-CL
----------	100	97	89	82	61	45	37	52	29	A-7-6(18)	CH
100	99	97	92	87	72	54	51	66	42	A-7-6(20)	CH
----------	100	99	97	93	80	62	55	74	50	A-7-6(20)	CH

fine material is analysed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are *not suitable* for use in naming textural classes for soil.

[2] Based on AASHO designation M 145-49 (*1*).

[3] Nonplastic.

TABLE 7.—*Estimates of soil*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear in the first column of this table. The symbol > means

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	*In.*			
Albaton:					
Ab	3-8	0-18	Silty loam	ML or CL	A-4 or A-6
		18-30	Silty clay	CH	A-7
		30-60	Silty clay	CH	A-7
Ac	3-8	0-60	Silty clay	CH	A-7
Alda:					
Af	2-6	0-20	Fine sandy loam	SM or ML	A-4
		20-60	Fine sand and gravel	SP, SM or SP-SM	A-2 or A-3
Ag	2-6	0-13	Very fine sandy loam	ML	A-7 or A-4
		13-20	Fine sandy loam	ML	A-4
		20-60	Sand and gravel	SP or SW	A-2 or A-3
Carr: Ca	5-8	0-15	Fine sandy loam	SM or ML	A-4
		15-36	Fine sandy loam	SM or ML	A-4
		36-50	Loam	ML or CL	A-4 or A-6
		50-60	Silty clay loam	CL or CH	A-7 or A-6
Cass:					
Cc	6-10	0-16	Fine sandy loam	SM or ML	A-4
		16-31	Fine sandy loam	SM or ML	A-4
		31-39	Loamy very fine sand	SM or SP-SM	A-2 or A-3
		39-60	Medium and coarse sand	SP or SP-SM	A-3 or A-2
Cd	6-10	0-10	Fine sandy loam	SM or ML	A-4
		10-38	Fine sandy loam	SM or ML	A-4
		38-60	Silty clay loam	CL or CH	A-6 or A-7
Ce	6-10	0-12	Very fine sandy loam	ML	A-4
		12-19	Very fine sandy loam	ML	A-4
		19-60	Fine sandy loam	SM or ML	A-4
*Colo: Cg, Ck For Kennebec part of Ck, see Kennebec series.	3-8	0-29	Silty clay loam	CL	A-7
		29-40	Silty clay loam	CL or CH	A-7
		40-55	Silt loam	ML or CL	A-4 or A-6
		55-60	Fine sandy loam	SM or SC	A-4
Cut and fill land: Cm. No valid estimates can be made.					
Dickinson: DcE	>10	0-30	Fine sandy loam	SM or ML	A-4
		30-60	Loamy sand	SP-SM or SM	A-2 or A-3
Eudora: Ed	6-10	0-7	Silt loam	ML	A-4
		7-13	Very fine sandy loam	ML	A-4
		13-60	Silt loam	ML	A-4
Gibbon:					
Ga	2-6	0-17	Loamy fine sand	SM	A-2
		17-60	Silty clay loam	CL	A-6 or A-7
Gb	2-6	0-40	Silt loam	ML or CL	A-4
		40-54	Silty clay loam	CL	A-6 or A 7
		54-60	Sand	SP-SM	A-2 or A3
Gc, Gs No valid estimates can be made for Slickspots part of Gs.	2-6	0-60	Silty clay loam	ML-CL or ML	A-6 or A-7

See footnote at end of table.

properties significant in engineering

such mapping units may have different properties and limitations, and for this reason, it is necessary to follow carefully the instructions for more than, < means less than. The depth to bedrock is more than 5 feet for all but Rock land]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permea-bility	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)						
						In./hr.	*In./in. of soil*	*pH*	
----------	100	90-100	70-90	30-40	5-20	0.6-2.0	0.22-0.24	7.4-7.8	Moderate.
----------	100	95-100	90-95	60-70	30-50	<0.06	0.11-0.13	7.4-7.8	High.
----------	100	95-100	90-95	60-70	30-50	<0.06	0.10-0.12	7.4-7.8	High.
----------	100	95-100	90-95	60-70	30-50	<0.06	0.12-0.14	7.4-7.8	High.
----------	100	70-85	40-55	[1] NP	NP	2.0-6.0	0.16-0.18	6.6-7.3	Low.
95-100	90-100	50-70	0-15	NP	NP	6.0-20.0	0.02-0.04	7.9-8.4	Very low.
----------	100	90-100	65-98	35-50	5-20	0.6-2.0	0.20-0.22	6.6-7.3	Low.
----------	100	95-100	55-70	NP	NP	2.0-6.0	0.15-0.17	7.9-8.4	Low.
95-100	95-100	50-80	0-10	NP	NP	>20.0	0.02-0.04	7.9-8.4	Very low.
100	95-100	70-85	40-55	NP	NP	2.0-6.0	0.16-0.18	7.4-7.8	Low.
100	95-100	70-85	40-55	NP	NP	2.0-6.0	0.15-0.17	7.4-7.8	Low.
----------	100	85-95	60-75	20-30	0-10	0.6-2.0	0.17-0.19	7.4-7.8	Low.
----------	----------	100	95-100	35-55	20-30	0.2-0.6	0.15-0.17	6.6-7.3	Moderate to high.
----------	100	70-85	36-55	NP	NP	2.0-6.0	0.16-0.18	5.6-6.0	Low.
----------	100	70-85	36-55	NP	NP	2.0-6.0	0.15-0.17	6.1-6.5	Low.
----------	100	90-100	5-20	NP	NP	6.0-20.0	0.08-0.10	6.6-7.3	Low.
----------	100	70-95	0-15	NP	NP	6.0-20.0	0.05-0.07	6.6-7.3	Very low.
----------	100	95-100	40-60	NP	NP	2.0-6.0	0.16-0.18	5.6-6.0	Low.
----------	100	95-100	40-60	NP	NP	2.0-6.0	0.15-0.17	6.1-6.5	Low.
----------	100	95-100	85-95	35-55	20-30	0.2-0.6	0.18-0.20	6.1-6.5	Moderate to high.
----------	100	85-95	51-65	NP	NP	0.6-2.0	0.20-0.22	5.6-6.0	Low.
----------	100	85-95	51-65	NP	NP	0.6-2.0	0.17-0.19	6.1-6.5	Low.
----------	100	70-85	40-55	NP	NP	2.0-6.0	0.14-0.16	6.6-7.3	Low.
----------	----------	100	95-100	40-50	20-25	0.2-0.6	0.21-0.23	6.6-7.3	Moderate to high.
----------	----------	100	95-100	40-60	20-35	0.2-0.6	0.18-0.20	6.1-6.5	Moderate to high.
----------	100	95-100	70-100	25-35	5-20	0.6-2.0	0.20-0.22	6.6-7.3	Moderate to high.
----------	100	70-85	36-50	15-30	0-10	2.0-6.0	0.14-0.16	6.6-7.3	Low.
----------	100	70-85	40-55	NP	NP	2.0-6.0	0.16-0.18	5.1-6.0	Low.
----------	100	50-75	5-20	NP	NP	6.0-20.0	0.08-0.10	5.1-6.0	Very low.
----------	100	90-100	70-90	NP	NP	0.6-2.0	0.22-0.24	6.6-7.3	Low.
----------	100	95-100	65-95	NP	NP	0.6-2.0	0.20-0.22	6.6-7.3	Low.
----------	100	90-100	70-98	NP	NP	0.6-2.0	0.20-0.22	7.4-7.8	Low.
----------	100	50-75	15-30	NP	NP	6.0-20.0	0.10-0.12	5.1-6.0	Low.
----------	100	95-100	85-95	35-45	20-30	0.2-0.6	0.18-0.20	7.9-8.4	Moderate.
----------	100	95-100	95-100	25-35	0-10	0.6-2.0	0.22-0.24	7.6-8.4	Moderate.
----------	100	95-100	85-95	35-45	20-30	0.2-0.6	0.18-0.20	7.9-8.4	Moderate.
----------	100	65-80	5-12	NP	NP	>20.0	0.05-0.07	7.4-7.8	Very low.
----------	100	90-100	51-70	35-45	15-30	0.2-0.6	0.21-0.23	7.9-8.4	Moderate.

TABLE 7.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	*In.*			
Gullied land: Gu. No valid estimates can be made.					
Haynie: Ha	4–8	0–60	Silt loam	ML or CL	A–4 or A–6
Ida: IdD2, IdE, IdE2	>10	0–60	Silt loam	ML or CL	A–7 or A–6
Inavale: Im, In	5–10	0–28	Loamy fine sand	SM or SP–SM	A–3 or A–2
		28–51	Fine sand	SM or SP–SM	A–2 or A–3
		51–60	Sand and gravel	SP or SP–SM	A–2 or A–3
Judson: JuB	8–10	0–37	Silt loam	ML or CL	A–6 or A–7
		37–60	Silty clay loam	CL or ML	A–7
Kennebec: Ke	8–10	0–60	Silt loam	ML or CL	A–6 or A–7
Lex noncalcareous variant: Le	2–6	0–21	Silt loam	ML or CL	A–6 or A–4
		21–28	Very fine sandy loam	ML	A–4
		28–60	Coarse sand and gravel	SP or SP–SM	A–2 or A–3
Luton:					
Ls	3–8	0–11	Silt loam	ML or CL	A–4 or A–6
		11–60	Silty clay	CH or MH	A–7
Lt	3–8	0–13	Silty clay loam	CL or CH	A–7
		13–60	Silty clay	CH	A–7
Lu	3–8	0–60	Silty clay	CH	A–7
*Marshall: MaA, MaB, MaC, MaC2, MaD, MeD2, MfE, MfE2. For Ponca part of MeD2, MfE, and MfE2, see Ponca series.	>10	0–15	Silty clay loam	ML or CL	A–4, A–6 or A–7
		15–39	Silty clay loam	CL or CH	A–7
		39–60	Silty clay loam	ML or CL	A 6 or A–7
*Monona: MoA, MoB, MoC, MoC2, MoD, MoD2, MoE, MsE2, MsF, MsF2, MsG. For Ida part of MsE2, MsF, MsF2, and MsG, see Ida series.	10	0–60	Silt loam	ML or CL	A–6 or A–7
Onawa: On	3–8	0–18	Silty clay	CH	A–7
		18–50	Silt loam	ML or CL	A–4 or A–6
		50–60	Fine sandy loam	SM or SC	A–4
Percival: Pa	3–8	0–16	Silty clay	CH or MH	A–7
		16–20	Loamy fine sand	SM	A–2
		20–60	Fine sand	SP or SP–SM	A–3 or A–2
Pits and dumps: Pb. No valid estimates can be made.					
Platte: Pc	2–5	0–12	Loam	ML	A–4
		12–60	Coarse sand and gravel	SP or SP–SM	A–2 or A–3
*Ponca: PdD2, PdE2. For Ida part of PdD2 and PdE2, see Ida series.	>10	0–60	Silty clay loam	ML or CL	A–6 or A–7
Riverwash: Ra. No valid estimates can be made.					
Rock land: Rk. No valid estimates can be made.					

See footnote at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permea-bility	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)						
						In./hr.	*In./in. of soil*	*pH*	
----------	100	95–100	70–100	30–40	5–20	0. 6–2. 0	0. 22–0. 24	7. 4–7. 9	Low to moderate.
----------	----------	100	98–100	35–45	11–20	0. 6–2. 0	0. 22–0. 24	7. 4–8. 2	Low to moderate.
----------	100	90–100	5–20	NP	NP	6. 0–20. 0	0. 10–0. 12	7. 4–7. 8	Very low.
----------	100	65–80	5–20	NP	NP	6. 0–20. 0	0. 05–0. 07	7. 4–7. 8	Very low.
95–100	85–100	50–70	0–15	NP	NP	>20. 0	0. 02–0. 04	7. 4–7. 8	Very low.
----------	----------	100	95–100	35–45	14–20	0. 6–2. 0	0. 22–0. 24	6. 9–7. 4	Low to moderate.
----------	----------	100	95–100	40–50	12–25	0. 6–2. 0	0. 18–0. 20	6. 1–6. 5	Moderate.
----------	----------	100	98–100	35–50	12–20	0. 6–2. 0	0. 22–0. 24	6. 1–7. 3	Low to moderate.
----------	----------	100	98–100	30–40	5–20	0. 6–2. 0	0. 22–0. 24	6. 1–6. 5	Low to moderate.
----------	100	95–100	65–90	NP	NP	0. 6–2. 0	0. 17–0. 19	6. 5–7. 3	Low.
95–100	85–100	50–70	2–12	NP	NP	>20. 0	0. 02–0. 04	7. 4–7. 8	Very low.
----------	----------	100	95–100	30–40	5–20	0. 6–2. 0	0. 22–0. 24	6. 6–7. 3	Moderate.
----------	----------	100	95–100	75–100	50–65	<0. 06	0. 10–0. 12	7. 5–8. 4	High.
----------	----------	100	95–100	40–55	20–30	0. 2–0. 6	0. 21–0. 23	6. 6–7. 3	Moderate to high.
----------	----------	100	95–100	75–95	50–55	<0. 06	0. 10–0. 12	7. 5–8. 4	High.
----------	----------	100	95–100	75–95	50–55	<0. 06	0. 12–0. 14	6. 6–7. 3	High.
----------	----------	100	95–100	30–45	8–20	0. 6–2. 0	0. 21–0. 23	5. 6–6. 5	Moderate.
----------	----------	100	95–100	45–60	20–30	0. 6–2. 0	0. 18–0. 20	6. 1–6. 5	Moderate.
----------	----------	100	95–100	35–50	15–25	0. 6–2. 0	0. 18–0. 20	6. 6–7. 3	Moderate.
----------	----------	100	88–100	30–45	11–25	0. 6–2. 0	0. 22–0. 24	5. 6–7. 3	Moderate.
----------	----------	100	95–100	60–70	30–50	0. 06–0. 2	0. 12–0. 14	7. 4–8. 4	High.
----------	----------	100	95–100	30–40	5–25	0. 6–2. 0	0. 22–0. 24	7. 9–8. 4	Moderate.
----------	100	70–85	36–50	18–25	0 5	2. 0 6. 0	0. 16 0. 18	7. 9 8. 4	Low.
----------	----------	100	95–100	60–70	30–50	0. 06–0. 2	0. 12–0. 14	7. 4–7. 8	High.
----------	100	50–75	12–30	NP	NP	6. 0–20. 0	0. 10–0. 12	7. 4–7. 8	Low.
----------	100	65–80	0–10	NP	NP	6. 0–20. 0	0. 02–0. 04	7. 4–7. 8	Low to very low.
----------	100	85–95	60–75	NP	NP	0. 6–2. 0	0. 22–0. 24	6. 9–8. 1	Low.
95–100	85–100	50–70	2–12	NP	NP	>20. 0	0. 02–0. 04	6. 0–7. 1	Very low.
----------	----------	100	95–100	35–45	11–20	0. 6–2. 0	0. 21–0. 23	7. 4–7. 8	Moderate.

TABLE 7.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	*In.*			
Rough broken land, loess: Rn. No valid estimates can be made.					
Sandy alluvial land: Sd. No valid estimates can be made.					
Sarpy: Sp	8–10	0–60	Fine sand	SP–SM	A–2 or A–3
Silty alluvial land: Ss. No valid estimates can be made.					
Steinauer: StE2	>10	0–18 18–60	Clay loam Clay loam	CL CL	A–6 or A–7 A–6 or A–7
Wabash:					
Wb	3–8	0–8 8–60	Silt loam Silty clay	ML or CL CH or MH	A 7 or A–6 A–7
Wc	3–8	0–60	Silty clay	CH or MH	A–7
Wann: Wm	2–6	0–50 50–60	Fine sandy loam Fine and coarse sand	SM SP or SP–SM	A–4 A–3 or A–2
Wet alluvial land: Wt. No valid estimates can be made.					

[1] Nonplastic.

TABLE 8.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two of more kinds of soil. The soils in such mapping units may have different
> means more than,

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Albaton: Ab,Ac	Severe: very slow permeability; occasional flooding; water table at a depth of 3 to 8 feet.	Slight if protected from flooding, severe if not. Moderate if water table is at a depth of 3 to 8 feet.	Severe: poorly drained; occasional flooding.	Severe: poorly drained; occasional flooding; high shrink-swell potential.	Severe: water table at a depth of 3 to 8 feet; poorly drained; occasional flooding.	Severe: poorly drained; occasional flooding; high shrink-swell potential; high susceptibility to frost action.
Alda: Af, Ag	Severe: water table at a depth of 2 to 6 feet.	Severe: water table at a depth of 2 to 6 feet; very rapid permeability below a depth of 3 feet.	Severe: water table at a depth of 2 to 6 feet; danger of caving.	Severe: water table at a depth of 2 to 6 feet; danger of caving.	Severe: water table at a depth of 2 to 6 feet; very rapid permeability below a depth of 3 feet.	Moderate: water table at a depth of 2 to 6 feet; subject to frost action.
Carr: Ca	Slight to moderate: moderately rapid permeability in upper part, moderately slow in substratum.	Severe: moderately rapid permeability in upper part; water table at a depth of 5 to 8 feet.	Moderate: moderately well drained to a depth of 5 feet; danger of caving.	Moderate to severe; water table at a depth of 5 to 8 feet; danger of caving.	Severe: water table at a depth of 5 to 8 feet; moderately rapid permeability in upper part.	Moderate: good compaction characteristics; moderate susceptibility to frost action.

See footnotes at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)						
						In./hr.	*In./in. of soil*	*pH*	
----------	100	65–80	5–12	NP	NP	6. 0–20. 0	0. 07–0. 09	7. 4–8. 1	Very low.
88–100	85–97	75–95	55–75	30–43	15–25	0. 6–2. 0	0. 17–0. 19	6. 8–8. 4	Moderate.
95–100	90–98	85–95	60–80	35–45	17–30	0. 6–2. 0	0. 14–0. 16	7. 9–8. 4	Moderate.
----------	----------	100	95–100	30–40	11–20	0. 6–2. 0	0. 22–0. 24	5. 6–6. 0	Moderate.
----------	100	95–100	90–100	50–75	25–50	<0. 06	0. 10–0. 12	6. 1–6. 5	High.
----------	100	95–100	90–100	50–75	25–50	<0. 06	0. 12–0. 14	5. 6–6. 0	High.
----------	100	70–85	36–50	NP	NP	2. 0–6. 0	0. 16–0. 18	7. 4–7. 8	Low.
95–100	90–100	51–80	0–15	NP	NP	6. 0–20. 0	0. 05–0. 07	7. 4–7. 8	Very low.

interpretations

properties and limitations, and for this reason, it is necessary to follow carefully the instructions for referring to other series that appear in the first colum of this table. The symbol < means less than]

Suitability as source of—			Soil features affecting—				
Road fill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Poor: high shrink-swell potential; susceptible to frost action; poorly drained.	[2]----------	Poor: poorly drained; poor workability; very firm consistence.	Low seepage; suitable for dug-outs in places.	Low permeability in compacted soil; fair to poor compaction characteristics.	Poor internal drainage and surface drainage; ponding in places; subject to overflow.	Moderate available water capacity; adequate drainage necessary; slow intake rate.	[3].
Fair: high water table limits depth of excavation in places.	Good to fair for fine sand below a depth of 2 feet.	Poor to fair: moderately deep over coarse sand and gravel.	High seepage; water table at a depth of 2 to 6 feet.	High permeability in compacted soil; fair to good compaction characteristics.	Good internal drainage; adequate outlets unavailable in places; water table at a depth of 2 to 6 feet.	Low available water capacity; rapid intake rate; sand and gravel at a depth of 20 to 30 inches.	[3].
Fair: moderate susceptibility to frost action; water table at a depth of 5 to 8 feet.	Poor----------	Good: subject to erosion.	Moderately rapid permeability in upper part; moderately slow in lower part.	Medium to low permeability in compacted soil; fair to good compaction characteristics.	Moderately rapid permeability in upper part; moderately slow in lower part.	High available water capacity; moderately rapid intake rate.	[3].

TABLE 8.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Cass: Cc, Cd, Ce	Slight to moderate: moderately slowly permeable layer at a depth of 3 feet in places.	Severe: moderately rapid permeability.	Slight above a depth of 6 feet, danger of caving for deeper excavations.	Slight above a depth of 6 feet; water table at a depth of 6 to 10 feet.	Severe for trench type, and area type feasible in places; moderately rapid permeability.	Moderate: moderate susceptibility to frost action.
*Colo: Cg, Ck. For Kennebec part of Ck, see Kennebec series.	Severe: moderately slow permeability; occasional flooding; water table at a depth of 3 to 8 feet.	Severe: high water table; occasional flooding.	Severe: occasional flooding; water table at a depth of 3 to 8 feet.	Severe: water table at a depth of 3 to 8 feet; moderate to high shrink-swell potential.	Severe: water table at a depth of 3 to 8 feet; occasional flooding.	Severe: occasional flooding; moderate to high shrink-swell potential.
Cut and fill land: Cm. No interpretations; material too variable.						
Dickinson: DcE	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: slope; moderately rapid permeability.	Moderate if slope is less than 15 percent, severe if more than 15 percent; danger of caving.	Moderate if slope is less than 15 percent, severe if more than 15 percent; subject to erosion.	Severe: moderately rapid permeability; soil material unable to slow downward movement of leachate.	Moderate if slope is less than 15 percent, severe if more than 15 percent.
Eudora: Ed	Slight	Severe: moderate permeability.	Slight above water table, subject to caving at or below water table; water table at a depth of 6 to 10 feet.	Slight to moderate: subject to consolidation if wetted and loaded; water table at a depth of 6 to 10 feet.	Moderate if water table is within range.	Moderate: ML; fair for subgrade if AASHO group index is 8; erodible.
*Gibbon: Ga, Gb, Gc, Gs. No interpretations for Slickspots part of Gs; material too variable.	Severe: water table at a depth of 2 to 6 feet.	Severe: water table at a depth of 2 to 6 feet.	Severe: water table at a depth of 2 to 6 feet; danger of caving.	Severe: water table at a depth of 2 to 6 feet.	Severe: water table at a depth of 2 to 6 feet; leachate can pollute ground water supply.	Moderate: water table at a depth of 2 to 6 feet.
Gullied land: Gu. No interpretations; material too variable.						
Haynie: Ha	Slight if protected from flooding; moderate permeability.	Moderate: water table at a depth of 4 to 8 feet; vertical permeability.	Moderate: moderately well drained; water table at a depth of 4 to 8 feet.	Slight if protected from flooding, severe if subject to flooding.	Severe for trench type, moderate to severe for area type; good cover soil; water table at a depth of 4 to 8 feet.	Moderate: erodible; low to moderate shrink-swell potential; moderate susceptibility to frost action.
Ida: IdD2, IdE, IdE2	Moderate if slope is less than 15 percent, severe if more than 15 percent.	Severe: moderate vertical permeability; excessive slope.	Moderate if slope is less than 15 percent, severe if more than 15 percent: danger of caving.	Moderate if slope is less than 15 percent, severe if more than 15 percent: subject to consolidation if wetted and loaded.	Good, but erodible cover soil.	Moderate if slope is less than 15 percent, severe if more than 15 percent; erodible.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair: subject to erosion; water table at a depth of 6 to 10 feet: moderate susceptibility to frost action.	In places, available below a depth of 5 feet.[2]	Good: subject to erosion.	Moderately rapid permeability.	Medium permeability in compacted soil; fair to good compaction characteristics; erodible.	Moderately rapid permeability.	Moderate available water capacity; moderately rapid intake rate.	([3]).
Fair to poor: water table at a depth of 3 to 8 feet; moderate to high shrink-swell potential.	([2])	Fair: poor workability because consistence is firm.	Water table at a depth of 3 to 8 feet.	Medium compressibility; low permeability in compacted soil; fair to poor compaction characteristics.	Poor surface drainage; adequate outlets unavailable in places; subject to overflow; moderately slow permeability; water table at a depth of 3 to 8 feet.	High available water capacity; moderately slow intake rate; adequate drainage necessary.	([3]).
Good to fair: moderate susceptibility to frost action.	Good for fine sand below a depth of 2.5 feet.	Fair to poor: slope is a limitation after excavation; erodible.	High seepage; moderately steep.	High permeability in compacted soil; fair to good compaction characteristics.	Somewhat excessively drained.	([3])	Highly erodible; difficult to vegetate.
Fair: ML; AASHO group index of 8; erodible.	([2])	Good: erodible if placed on slopes.	Subject to seepage	Medium to low permeability in compacted soil; fair to poor compaction characteristics.	Good surface drainage; moderate permeability.	High available water capacity.	([3]).
Poor: water table at a depth of 2 to 6 feet.	Sand below a depth of 6 feet in places.[2]	Good to fair above the water table: poor workability in places.	Water table at a depth of 2 to 6 feet; suitable for dugouts.	Low permeability in compacted soil; fair to good compaction characteristics.	Poor surface drainage; adequate outlets unavailable in places; water table at a depth of 2 to 6 feet; moderate permeability.	High available water capacity; water table at a depth of 2 to 6 feet.	([3]).
Fair: moderate shrink-swell potential; susceptible to frost action.	([2])	Good	Dugouts possible in places; subject to vertical seepage.	Medium to low permeability in compacted soil; fair compaction characteristics.	Good surface drainage; moderate permeability; water table at a depth of 4 to 8 feet.	High available water capacity.	([3]).
Good: erodible; borrow areas steep in places.	([2])	Fair: slope; low fertility; erodible if placed on slopes.	High vertical permeability; slope.	Low permeability in compacted soil; fair compaction characteristics.	Good surface drainage; well drained.	High available water capacity; low fertility; highly erodible.	Erodible; high siltation rate can result in high maintenance; excessive slope in MsG in places.

TABLE 8.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Inavale: Im, In	Moderate: water table at a depth of 5 to 10 feet; high vertical permeability; potential underground water supply.	Severe: rapid permeability.	Severe: danger of caving; water table at a depth of 5 to 10 feet.	Moderate to severe: water table at a depth of 5 to 10 feet; danger of caving.	Severe: water table at a depth of 5 to 10 feet; leachate can flow into water table; poor cover soil.	Slight to moderate: erodible by wind and water; poor surface if unpaved.
Judson: JuB	Moderate: moderate permeability; larger fields required in places.	Moderate: moderate permeability.	Slight to moderate: danger of caving.	Moderate to severe: moderate shrink-swell potential; occasional flooding in places.	Slight for area type	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action.
Kennebec: Ke	Severe: occasional flooding.	Moderate: moderate permeability. Severe if subject to flooding.	Severe: occasional flooding; danger of caving.	Severe: occasional flooding.	Severe: occasional flooding.	Severe: occasional flooding.
Lex noncalcareous variant: Le	Severe: water table at a depth of 2 to 6 feet.	Severe: water table at a depth of 2 to 6 feet.	Severe: water table at a depth of 2 to 6 feet.	Severe: water table at a depth of 2 to 6 feet; basements not feasible.	Severe: gravel and sand in lower substratum; water table at a depth of 2 to 6 feet; not suited.	Moderate: moderate shrink-swell potential; susceptible to frost action in upper 2 feet; water table at a depth of 2 to 6 feet.
Luton: Ls, Lt, Lu	Severe: relatively impermeable; water table at a depth of 3 to 8 feet.	Moderate: water table at a depth of 3 to 8 feet.	Severe: water table at a depth of 3 to 8 feet; difficult to excavate or compact.	Severe: high shrink-swell potential; water table at a depth of 3 to 8 feet.	Severe: poor workability; water table at a depth of 3 to 8 feet; poor cover soil.	Severe: high shrink-swell potential; susceptible to frost action; difficult to excavate or transport.
*Marshall: MaA, MaB, MaC, MaC2, MaD, MeD2, MfE, MfE2. For Ponca part of MeD2, MfE, and MfE2, see Ponca series.	Moderate: moderate permeability; slope is more than 8 percent in places.	Slight if slope is less than 2 percent; needs compaction for sealing in places; slope makes installation difficult in places.	Slight: danger of caving if wetted.	Slight if slope is less than 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Slight for area type. Moderate for existing slopes.	Moderate: moderate shrink-swell potential. Severe if slope is more than 15 percent; subject to frost action.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Good, but needs adequate compaction control.	Poor: fine sand	Poor: coarse	Rapid permeability.	Medium permeability in compacted soil; fair compaction characteristics; subject to horizontal seepage.	Somewhat excessively drained; rapid permeability.	Low available water capacity; erodible by wind and water; droughty.	(3).
Fair: moderate shrink-swell potential; susceptible to frost action; needs compaction control.	(2)	Good: erodible if placed on slopes.	Moderate seepage	Medium compressibility; low permeability in compacted soil; fair compaction characteristics.	Moderate permeability.	High available water capacity.	Erodible slopes.
Fair: moderate shrink-swell potential; susceptible to frost action; needs compaction control.	(2)	Good: erodible if placed on slopes.	Moderate seepage	Medium compressibility; low permeability in compacted soil; fair compaction characteristics.	Moderate permeability; subject to occasional flooding.	High available water capacity.	(3).
Fair: moderate shrink-swell potential in upper 2 feet; susceptible to frost action; water table at a depth of 2 to 6 feet.	Good below a depth of 30 inches; needs pumping or dewatering to excavate.	Fair: water table at a depth of 2 to 6 feet.	High water table at a depth of 2 to 6 feet.	Fair compaction characteristics; division of soil materials at a depth of 2 feet.	Water table at a depth of 2 to 6 feet; moderate permeability in upper part, very rapid in lower part.	Moderate available water capacity; water table at a depth of 2 to 6 feet; limited; rooting depth.	(3).
Poor: high shrink-swell potential; susceptible to frost action; water table at a depth of 3 to 8 feet limits depth of excavation.	(2)	Poor: plasticity is too high for suitable topsoil.	Water table at a depth of 3 to 8 feet; very slow permeability.	High compressibility; low permeability in compacted soil; poor compaction characteristics; difficult to excavate.	Ponding in places; adequate outlets unavailable in places; very slow permeability; water table at a depth of 3 to 8 feet.	Moderate available water capacity; slow intake rate; difficult to work.	(3).
Good to fair: moderate shrink-swell potential; subject to frost action; existing slopes can cause steep haul grades.	(2)	Good to fair: slope; erodible by water; firm consistence in places.	Moderate permeability; requires sealing or lining in places.	Medium compressibility; low permeability in compacted soil; good compaction characteristics; erodible by water.	Well drained; good surface drainage; moderate permeability.	High available water capacity; subject to erosion; not suited if slope is more than 9 percent.	All features favorable.

TABLE 8.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
*Monona: MoA, MoB, MoC, MoC2, MoD, MoD2, MoE, MsE2. For Ida part of MsE2, see Ida series.	Slight if slope is less 2. than 8 percent, moderate if 8 to 15 percent.	Moderate: moderate permeability. Severe if slope is more than 7 percent.	Slight if slope is less than 8 percent, moderate if 8 to 15 percent.	Slight to moderate: moderate shrink-swell potential; high susceptibility to frost action; slope.	Slight if slope is 0 to 15 percent: good workability. Moderate if slope is 15 to 25 percent: suitable for area or trench type.	Moderate: moderate shrink-swell potential; subject to frost action; erodible by water.
MsF, MsF2, MsG. For Ida part of MsF, MsF2, and MsG, see Ida series.	Severe: slope is more than 15 percent.	Severe: slope is more than 7 percent.	Severe if slope is more than 15 percent.	Severe: slope is more than 15 percent.	Severe: slope is more than 25 percent; existing slopes generally require area type landfill.	Severe: slope is more than 15 percent; erodible by water.
Onawa: On	Severe: water table at a depth of 3 to 8 feet; occasional flooding.	Severe: water table at a depth of 3 to 8 feet.	Severe: subject to caving; water table at a depth of 3 to 8 feet.	Severe: water table at a depth of 3 to 8 feet; high shrink-swell potential in upper 2 feet; high susceptibility to frost action.	Severe: occasional flooding; water table at a depth of 3 to 8 feet.	Severe: high shrink-swell potential in upper 2 feet; subject to frost action; occasional flooding.
Percival: Pa	Severe: slow permeability in upper part, rapid in lower part; water table at a depth of 3 to 8 feet.	Severe: water table at a depth of 3 to 8 feet; rapid permeability below a depth of 1.5 feet.	Severe: occasionally flooded; high danger of caving; water table at a depth of 3 to 8 feet.	Severe: high shrink-swell potential in upper part; water table at a depth of 3 to 8 feet; sand below a depth of 1.5 feet; occasionally flooded.	Severe: rapid permeability below a depth of 1.5 feet; water table at a depth of 3 to 8 feet; occasionally flooded; poor cover soil.	Severe: high shrink-swell potential in upper 1.5 feet; occasional flooding.
Pits and dumps: Pb. No interpretations; material too variable.						
Platte: Pc	Severe: not applicable on this soil; water table at a depth of 2 to 5 feet; sand below a depth of 1 foot.	Severe: not applicable on this soil unless positive lining is used; water table at a depth of 2 to 5 feet; very rapid permeability below a depth of 1.5 feet.	Severe: water table at a depth of 2 to 5 feet; subject to caving.	Severe: water table at a depth of 2 to 5 feet; occasional flooding; needs waterproofing.	Severe: not suited on this soil; water table at a depth of 2 to 5 feet; occasional flooding; very rapid permeability below a depth of 1.5 feet.	Slight to severe: hazard of flooding; needs fill in places.
*Ponca: PdD2, PdE2. For Ida part of PdE2 and PdD2, see Ida series.	Moderate if slope is 8 to 15 percent: moderate permeability. Severe if slope is more than 15 percent.	Severe: slope	Moderate if slope is 8 to 15 percent, severe if more than 15 percent.	Moderate if slope is 8 to 15 percent, severe if more than 15 percent.	Slight if slope is less than 15 percent, moderate if 15 to 25 percent.	Moderate if slope is 8 to 15 percent: moderate shrink-swell potential. Severe if slope is more than 15 percent.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair: moderate shrink-swell potential; subject to frost action; good workability; extends vertically to great depths.	(2)	Good if slope is less than 8 percent; erodible by wind and water.	Vertical permeability requires sealing or lining.	Medium compressibility; low permeability in compacted soil; good compaction characteristics.	Well drained; good surface drainage; moderate permeability.	High available water capacity; subject to water erosion.	Suitable if slope is up to 17 percent; highly erodible by water if more than 17 percent.
Good for fill soil. Fair if steep haul grades.	(2)	Severe: slope	Limited storage on steep slopes; vertical permeability requires sealing or lining.	Medium compressibility; low permeability in compacted soil; good compaction characteristics; subject to excessive consolidation if wetted and loaded.	Rapid to very rapid runoff; moderate permeability.	(3)	Msg too erodible and steep.
Poor to a depth of about 2 feet: clayey. Fair below a depth of 2 feet: silty; depth of excavation limited by water table at a depth of 3 to 8 feet.	(2)	Poor: high clay content to a depth of 2 feet; very firm consistence.	Slow permeability in upper 2 feet, moderate below a depth of 2 feet; water table at a depth of 3 to 8 feet.	Low permeability in compacted soil; fair to poor compaction characteristics.	Slow permeability in upper part, moderate in lower part; water table at a depth of 3 to 8 feet.	High available water capacity; slow intake rate in upper 2 feet; difficult to work.	(3).
Poor to fair: high clay content to a depth of 2 feet, sand below; water table at a depth of 3 to 8 feet.	Fair to good for fine sand below a depth of 3 feet; water table at a depth of 3 to 8 feet.	Poor: high clay content; sand below a depth of 2 feet.	Low seepage in upper 2 feet; water table at a depth of 3 to 8 feet.	Water table at a depth of 3 to 8 feet; high clay content in upper soil, fine sand below; sand fill subject to seepage.	Slow permeability in upper part; water table at a depth of 3 to 8 feet.	Low available water capacity; slow intake rate in upper 2 feet; difficult to work.	(3).
Good: sand can be dewatered or mined hydraulically.	Good for fine sand: no gravel in upper 5 feet hydraulically mined.	Poor: inadequate depth; erodible by wind and water.	High seepage; high water table; dugouts and sand pits generally obtained.	Good foundation for strength; subject to seepage in fill and foundation; sand is easily compacted by hauling equipment.	Water table at a depth of 2 to 5 feet; shallow over coarse sand and gravel.	Low available water capacity; shallow effective rooting depth; water table at a depth of 2 to 5 feet.	(3).
Fair: moderate shrink-swell potential; extends vertically to a great depth; good workability.	(2)	Fair if slope is 8 to 15 percent, poor if more than 15 percent: erodible by wind and water.	Moderate seepage requires sealing or lining.	Medium to low shear strength; subject to seepage in fill and foundation; medium compressibility; medium to low permeability in compacted soil; fair compaction characteristics.	Well drained; good surface drainage; moderate permeability.	High available water capacity; highly erodible slope.	Suitable if slope is 15 percent or less; highly erodible by water if more than 15 percent.

TABLE 8.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Riverwash: Ra. No interpretations; material too variable.						
Rock land: Rk. No interpretations; material too variable.						
Rough broken land, loess: Rn. No interpretations; material too variable.						
Sandy alluvial land: Sd. No interpretations; material too variable.						
Sarpy: Sp	Severe: rapid permeability; occasional flooding.	Severe: rapid permeability; occasional flooding; needs sealing or lining.	Severe: danger of caving.	Slight if protected from flooding, severe if not.	Severe: occasional flooding; rapid permeability; poor cover soil allows release of gases; erodible; rapid permeability; leaching.	Moderate: occasional flooding; erodible by water; surface needs paving or other protection.
Silty alluvial land: Ss. No interpretations; material too variable.						
Steinauer: StE2	Severe. slope	Severe: slope increases cost of construction.	Severe: slope is more than 15 percent; poor workability; high clay content makes backfilling more difficult.	Moderate to severe: slope.	Moderate to severe: slope; poor workability; cover soil poor below a depth of 1.5 feet.	Severe if slope is more than 15 percent: subject to frost action.
Wabash: Wb, Wc	Severe: very slow permeability; water table at a depth of 3 to 8 feet.	Moderate to severe: water table at a depth of 3 to 8 feet; limited to construction above water table.	Severe: water table at a depth of 3 to 8 feet; poor for backfill.	Severe: high shrink-swell potential; water table at a depth of 3 to 8 feet.	Severe: seasonal high water table; poor cover soil; subject to shrinkage cracks.	Severe: high shrink-swell potential; subject to frost action; poor compaction characteristics.
Wann: Wm	Severe: water table at a depth of 2 to 6 feet; moderately rapid permeability.	Severe: moderately rapid permeability; water table at a depth of 2 to 6 feet.	Severe: danger of caving; water table at a depth of 2 to 6 feet.	Severe: water table at a depth of 2 to 6 feet; waterproofing for basements is costly.	Severe: not suitable; water table at a depth of 2 to 6 feet.	Moderate to severe: subject to frost action; water table at a depth of 2 to 6 feet.
Wet alluvial land: Wt. No interpretations; material too variable.						

[1] Onsite study is needed of the underlying strata, the water table, and the hazards of aquifer pollution and drainage into ground water in landfill deeper than 5 or 6 feet.
[2] No sand or gravel available within 5 feet of surface.

interpretations—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Good if confined to nearly level areas and banks are vegetated.	Fair: poorly graded, fine sand, few aggregate-sized particles.	Poor: fine sand, erodible by wind.	High seepage; rapid permeability; needs lining to retain water.	Low compressibility; high permeability in compacted soil; good compaction characteristics; subject to seepage if foundation becomes saturated.	Excessively drained; rapid permeability.	Low available water capacity; rapid intake rate; erodible by wind.	(3).
Poor: compaction difficult to control; slope affects haul grades.	(2)	Fair to a depth of 20 inches, poor below: slope; thin surface layer.	Low seepage; moderate vertical and horizontal permeability.	Low permeability in compacted soil; fair to poor compaction characteristics.	Well drained	(3)	Moderately steep and steep; stones and gravel in places.
Poor: high shrink-swell potential; susceptible to frost action; poorly drained.	(2)	Poor: high clay content; poor workability; poorly drained.	Very slow permeability; water table at a depth of 3 to 8 feet.	Low permeability in compacted soil; fair to poor compaction characteristics.	Poorly drained; water table at a depth of 3 to 8 feet; very slow permeability.	Moderate available water capacity; slow intake rate; difficult to work.	(3).
Fair to poor: needs dewatering; water table at a depth of 2 to 6 feet.	Poor: high percentage of fines; good below a depth of 5 feet in places.	Good to fair: highly erodible slopes.	Water table at a depth of 2 to 6 feet.	Medium to low permeability in compacted soil; fair to good compaction characteristics; subject to horizontal seepage.	Somewhat poorly drained; water table at a depth of 2 to 6 feet.	Moderate available water capacity; moderately rapid intake rate; water table at a depth of 2 to 6 feet.	(3).

[3] Soil characteristics, slope, and position make these structures unsuited to or unnecessary on this soil.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils for sanitary landfill have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 8 apply only to a depth of about 6 feet. If trenches are to be much deeper, limitation ratings of slight or moderate may not be valid. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but every site still should be investigated before it is selected.

Local roads and streets, as rated in table 8, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity, stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHO and Unified classifications of the soil material and the shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect the ease of excavation and the amount of cut and fill needed to reach an even grade.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage, and the relative ease of excavating the material at borrow areas.

Sand is used in great quantities in many kinds of construction. The ratings in table 8 provide guidance on where to look for probable sources. A soil rated as a good or fair source of sand generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and they do not indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants if fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and content of stone fragments are characteristics that affect suitability. Also considered in the ratings is damage that results at the area from which topsoil is removed.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that resists seepage and piping and has favorable stability, shrink-swell potential, shear strength, and compactibility. Stones or organic material in a soil are among factors that are unfavorable.

Drainage of crops and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock. Further information on use of the soil for irrigation is contained in "Irrigation Guide for Nebraska," Soil Conservation Service, 1971.

Terraces and diversions are embankments or ridges constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Formation and Classification of the Soils

This section explains how the factors of soil formation have affected the formation of soils in Douglas and Sarpy Counties. It also explains the system of soil classification currently used and classifies all the soil series in the survey area according to that system.

Factors of Soil Formation

Soil is produced by soil-forming processes that act on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineral composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into soil material that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. A long time is generally required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

The soils of Douglas and Sarpy Counties formed in three kinds of parent material, Peoria Loess and younger loess, glacial till, and alluvium.

Nearly all of the upland is covered by 10 to 50 feet of light brownish-gray or pale-brown Peoria Loess. Soils of the Marshall and Monona series formed in this material. Beneath this loess is a thin layer of brown loess that crops out on the hillsides in a few places, but is not the parent material of any of the soils in the survey area. Glacial drift is below the brown loess and is exposed at the base of slopes along some of the major streams and in deep gullies. It is clayey and contains some gravel, pebbles, and small stones. The total area of soils formed in drift is small because these exposures are only in scattered areas. These areas are mapped as Steinauer soils.

The soils on the bottom land in the valleys of the Platte, Elkhorn, and Missouri Rivers formed in alluvium of recent age. This alluvium ranges from clay to sand and is commonly stratified. The alluvium was deposited, to a depth of 1 to 8 feet, over mixed sand and gravel. The most recent alluvium is in upland drains and on the bottom land along the major streams where fresh material is deposited by flooding after heavy rains. Eudora, Haynie, Gibbon, and Sarpy soils formed in alluvium.

The alluvium along the smaller streams is derived from the adjacent upland. The alluvium in the flood plains of the Platte, Elkhorn, and Missouri Rivers is mixed deposits transported by the streams and material derived from the adjacent uplands and from more distant areas.

One bedrock formation, sandstone of the Dakota Group, is exposed in small areas along the bluffs adjacent to Papillion Creek, the Elkhorn River, and the Platte River. Some areas of the sandstone are exposed along road cuts and new housing developments. These areas are indicated by a special symbol on the detailed soil map. Soils formed in sandstone are not mapped in the survey area, but are included with the land type, Rock land.

Limestone bedrock is exposed in small areas along the bluffs of the Platte River and entrenched drainageways. These areas are part of the mapping unit Rock land.

Climate

The climate is marked by extreme summer and winter temperatures. The average annual temperature is 50° F. The average annual precipitation is approximately 28 to 30 inches. Damaging hailstorms are infrequent. The average number of days without a killing frost is 167 in the rural areas and 183 in Omaha. If moisture is sufficient, frost penetrates to depths of 2 to 3.5 feet. The prevailing direction of the wind is from the south or southeast from May to September and from the northwest during the rest of the year.

Climate, directly and indirectly, causes variations in plant and animal life and is a factor in the formation of the soils. The climate helped to produce the mid and tall prairie grasses that were the original vegetation. Only rainfall that continues for prolonged periods is sufficient to leach the soils deeply. Many of the mature soils in this survey area, for example Monona and Marshall soils, have a thick, dark-colored, granular surface layer and free carbonates in the lower part of the subsoil.

Plants and animals

After the parent material was deposited, bacteria, fungi, and other simple forms of life invaded it. After a time, prairie grasses began to grow. The fibrous roots in the upper few feet of the soil made it porous and encouraged the development of granular structure.

As living matter eventually died and was returned to the soil, it was acted upon by bacteria and various kinds of fungi, causing the decay of organic matter into humus. Earthworms and small burrowing animals helped to mix the humus with the soil.

The accumulation of decayed organic matter gradually darkens the color and changes the physical and chemical characteristics of the surface layer. The soil is enriched by plant nutrients from the decaying organic matter. The tilth is improved, permeability to air and water is established, and water movement into and through the soil is increased. Colo and Judson soils have high organic-matter content; Ida and Inavale soils have low organic-matter content.

Relief

Relief, or the lay of the land, influences soil formation through its effect on water movement through the soil and over the surface. On nearly level, well-drained uplands and stream terraces of this survey area the soils are deep and have well-expressed horizons. Marshall and Monona soils are examples of this kind of soil. Steep soils absorb less moisture and normally have a less well expressed profile. Ida and Steinauer soils are examples of this kind of soil. Nearly level soils on bottom land receive extra water through runoff from adjacent slopes, and in these areas, the soils may be wet for long periods of time. The flow of water in these soils is often controlled more by the movement of ground water than it is by relief. Colo and Gibbon soils are examples.

Differences in the lay of the land slow some processes of horizon differentiation and hastens others. Relief is a local factor in soil formation. Ordinarily, soils that have gentle slopes have a thick solum and distinct horizons; soils that have steeper slopes have a thinner solum and less distinct horizons.

Time

Time is required for the formation of a mature soil. These mature, or old, soils have a thick, dark-colored surface layer and a distinct subsoil. They are approaching equilibrium with their environment. Marshall and Monona soils are examples of mature soils.

Most soils on bottom land lack well-expressed horizons because new deposits of alluvium are laid down before soil formation can take place. Steep soils have been in place long enough for horizons to form, but soil material is removed from the steep slope before well-expressed horizons can form. Haynie and Sarpy soils are examples of immature soils on bottom land, and Ida and Steinauer soils are examples of steep, immature soils on uplands.

Classification of the Soils

The purpose of soil classification is to help us remember the significant characteristics of soils, assemble our knowledge about the soils, see their relationships to one another and to the whole environment, and develop principles relating to their behavior and their response to manipulation. First through classification and then through the use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The current system of soil classification (*3*, *5*) was adopted by the Cooperative Soil Survey in 1965. It is a comprehensive system, designed to accommodate all soils. In this system classes of soils are defined in terms of observable or measurable properties. The properties chosen are mainly those that result in the grouping of soils of similar genesis, or mode of origin. Genesis does not, however, appear in the definitions of the classes.

The current system of classification has six categories. Beginning with the most inclusive, the categories are the order, the suborder, the great group, the subgroup, the family, and the series. Table 9 shows the classification of the soils of Douglas and Sarpy Counties according to this system. The classification is current as of August 1973. Brief descriptions of the six categories follow.

Order.—Ten soil orders are recognized: Entisols, Vertisoils, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate orders are those that tend to give broad climatic groupings of soils. Two exceptions to this generalization are the Entisols and the Histosols, which occur in many different climates. Two of the ten orders are represented in Douglas and Sarpy Counties: Entisols and Mollisols.

Suborder.—Each order is divided into suborders, mainly on the basis of soil characteristics that result in grouping soils according to genetic similarity. The climatic range is narrower than that of the order. The properties used are mainly those that reflect the presence or absence of a water table at a shallow depth; soil climate; the accumulation of clay, iron, or organic carbon in the upper part of the solum; cracking of soils caused by a decrease in soil moisture; and fine stratification.

Great group.—Each suborder is divided into great groups on the basis of similiarity in the kind and sequence of the major horizons and in major soil properties. The horizons considered are those in which clay, iron, or humus have accumulated and those in which pans that interfere with the growth of roots and the movement of water have formed. The properties are soil temperature, chemical composition (mainly content of calcium, magnesium, sodium, and potassium), and the like.

Subgroup.—Each great group is divided into subgroups, one that represents the central (typic) concept of the group, and others, called intergrades, that have one or more properties of another great group, suborder, or order.

Family.—Families are established within each subgroup, primarily on the basis of properties important to

TABLE 9.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Albaton	Fine, montmorillonitic (calcareous), mesic	Vertic Fluvaquents	Entisols.
Alda	Coarse-loamy, mixed, mesic	Fluvaquentic Haplustolls	Mollisols.
Carr	Coarse-loamy, mixed (calcareous), mesic	Typic Udifluvents	Entisols.
Cass	Coarse-loamy, mixed, mesic	Fluventic Haplustolls	Mollisols.
Colo	Fine-silty, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Dickinson	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Eudora	Coarse-silty, mixed, mesic	Fluventic Hapludolls	Mollisols.
Gibbon [1]	Fine-silty, mixed (calcareous), mesic (acric)	Typic Haplaquolls	Mollisols.
Haynie	Coarse-silty, mixed (calcareous), mesic	Typic Udifluvents	Entisols.
Ida	Fine-silty, mixed (calcareous), mesic	Typic Udorthents	Entisols.
Inavale	Mixed, mesic	Typic Ustipsamments	Entisols.
Judson	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Lex noncalcareous variant.	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic.	Typic Haplaquolls	Mollisols.
Luton	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Marshall [2]	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Monona [3]	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Onawa	Clayey over loamy, montmorillonitic (calcareous), mesic	Mollic Fluvaquents	Entisols.
Percival	Clayey over sandy or sandy-skeletal, montmorillonitic (calcareous), mesic.	Aquic Udifluvents	Entisols.
Platte	Sandy, mixed, mesic	Mollic Fluvaquents	Entisols.
Ponca [4]	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Sarpy	Mixed, mesic	Typic Udipsamments	Entisols.
Steinauer	Fine-loamy, mixed (calcareous), mesic	Typic Udorthents	Entisols.
Wabash	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Wann	Coarse-loamy, mixed, mesic	Fluvaquentic Haplustolls	Mollisols.

[1] The Gibbon soils in this survey area are taxadjuncts to the Gibbon series because the calcium carbonate content is less than 5 percent.

[2] The Marshall soils in mapping units MaC2, MeD2, and MfE2 are taxadjuncts to the Marshall series because the surface layer is thinner and lighter colored than is defined as the range for the series.

[3] The Monona soils in mapping units MoC2, MoD2, MsE2, and MsF2 are taxadjuncts to the Monona series because the surface layer is thinner and lighter colored than is defined as the range for the series.

[4] The Ponca soils in mapping units MeD2, MfE2, PdD2, and PdE2 are taxadjuncts to the Ponca series because the surface layer is thinner and lighter colored than is defined as the range for the series.

the growth of plants or properties significant in engineering. Texture, mineral content, reaction, soil temperature, permeability, thickness of horizons, and consistence are among the properties considered.

Series.—A series is a group of soils that has horizons similar in all important characteristics, except for texture of the surface layer, and similar in arrangement in the profile. (See the section "How This Survey Was Made.")

Mechanical and Chemical Analysis

Samples from soil profiles were collected for mechanical and chemical analysis by the Soil Conservation Service, Soil Survey Laboratory in Lincoln, Nebraska. Soils of the Cass, Luton, Marshall, Monona, Wabash, and Wann series were sampled in nearby counties and the data is recorded in Soil Survey Investigations Report Number 5 (*6*).

This information is useful to soil scientists in classifying soils and in developing concepts of soil genesis. It is also helpful in estimating available water capacity, soil blowing, fertility, tilth, and other practical aspects of soil management. Data on reaction, electrical conductivity, and percentage of exchangeable sodium help in evaluating the possibility of reclaiming and managing saline-alkali areas.

Environmental Factors Affecting Soil Use

The soils in Douglas and Sarpy Counties are used for cultivated crops, windbreaks, grazing, urban and industrial development, and as wildlife habitat and woodland. All of these uses are affected by the natural and cultural features in the counties. Important natural features that determine use of the soils are physiography, relief, drainage, climate, water, and natural vegetation. Cultural features are transportation facilities and manufacturing and business services. This section describes each of these factors and relates it to the current use of the soil and the trends toward future use.

Physiography, Relief, and Drainage

This survey area is part of the Great Plains physiographic province. The upland is covered with a deep mantle of wind-deposited Peoria Loess and younger loess. This is underlain by deposits of glacial till of different ages. These deposits are exposed only along the base of some slopes as scattered outcrops. Bedrock, underlying the glacial till, consists mostly of limestone and partly of pale, reddish-brown sandstone. The latter crops out in a few places in very steep and rough broken areas that border a stream or river.

The Elkhorn, Platte, and Missouri River Valleys are nearly level to very gently sloping. The areas of strongest relief are in the bluff areas where slopes are steep and very steep. Maximum relief is about 230 feet in the bluffs in the northern part of Omaha and 270 feet in those north of Bellevue. At Elkhorn Bluffs east of King Lake it is 190 feet. The nearly level upland divides are small. The headward advance of numerous small drainageways in places gives them an irregular outline. The rest of the survey area is a succession of ridges, sloping areas, and valleys. The ridges are rounded and moderately sloping, and the slopes to the valleys are strongly sloping to moderately steep. The wider valleys are nearly level. Small drainageways cross the area and empty into the larger streams.

The highest elevation is 1,300 feet on the divide north of Elk City in Douglas County and also on the divide north of Gretna in Sarpy County. The lowest elevation is 950 feet at the junction of the Platte and Missouri Rivers in the extreme southeastern corner of the survey area. Of the streams in the survey area, Deer Creek flows to the north, Ponca and Mill Creeks flow to the east, and the rest flow toward the south or southeast. The Missouri River, the largest and only navigable river, drains the eastern part of the survey area. Big Papillion and Little Papillion, Thomas, Knight, Hell, Box Elder, and Buffalo Creeks drain the central part. The Elkhorn and Platte Rivers drain the western and southern parts of the survey area. Nearly all the rivers and major creeks flow constantly, except during prolonged droughts.

Climate [9]

Douglas and Sarpy Counties are in east-central Nebraska near the center of the United States. The Missouri River, along the eastern border of these counties, has only a small influence on the weather. The climate is distinctly continental. Summers are warm, winters are cold, and rainfall is moderate. The temperature and rainfall vary greatly, however, from day to day and season to season. Most of the rain that falls is the result of southerly winds that bring moist air from the Gulf of Mexico. The rapid changes of temperature are caused by the interchange of warm air from the south and southwest with the cold air from the north and northwest. Table 10 shows the temperature and precipitation data for the counties, and table 11 shows probable dates of specified low temperatures in spring and fall.

About three-fourths of the annual precipitation falls during the period April through September. This period covers the major part of the active growing season. Precipitation early in spring is slow and steady and is well distributed. As the summer advances, more and more of the rain falls during erratic thundershowers. By the latter part of May, nearly all of the precipitation falls during such showers. The showers frequently are at night, and the skies clear by early morning. Summer sunshine is abundant, averaging about 75 percent of the possible amount. Locally, drought develops if the time or distribution of showers is poor.

It is not unusual for wind gusts to reach speeds of 60 to 80 miles per hour in areas near severe thunderstorms. The fastest wind on record at Omaha is 109 miles per hour. The winds and hailstorms associated with severe thunderstorms are generally local in extent, of short duration, and produce damage in an extremely variable and spotted pattern. Although crop destruction is 100 percent near the center of the storm, the rains cover a much larger area, and the overall benefits generally exceed the losses.

Fall is characterized by an abundance of sunshine, mild days, and cool nights. Most of the winter precipitation is in the form of snow, generally light, but occasionally heavy.

[9] Prepared by RICHARD E. MYERS, State climatologist for Nebraska, National Weather Service, U.S. Department of Commerce.

TABLE 10.—*Temperature and precipitation data*

[All data from Omaha, Nebr. Elevation 1,040 feet]

Month	Temperature [1]				Precipitation [2]				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average total	One year in 10 will have—		Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Equal to or less than—	Equal to or more than—		
	° F.	° F.	° F.	° F.	Inches	Inches	Inches	Number	Inches
January	31	13	51	−7	0.7	0.2	1.5	17	3
February	36	17	57	−2	.9	.1	2.0	11	4
March	47	28	70	8	1.4	.4	3.0	8	5
April	62	41	83	27	2.6	.8	4.7	(3)	1
May	73	53	89	38	3.8	1.3	6.7	0	----------
June	82	62	97	51	4.6	1.6	7.5	0	----------
July	88	67	102	56	3.7	.8	7.4	0	----------
August	85	65	99	55	3.4	1.1	7.1	0	----------
September	77	56	95	41	3.1	.7	5.7	0	----------
October	66	44	85	29	2.1	.5	4.6	0	----------
November	49	30	70	12	1.2	.1	2.9	2	3
December	36	19	57	−5	.9	.1	1.8	8	4
Year	61	41	[4] 101	[5] −14	28.4	19.9	37.8	46	4

[1] Based on 99 years of temperature data.
[2] Based on 101 years of precipitation data.
[3] Less than half a day.
[4] Average annual maximum.
[5] Average annual minimum.

TABLE 11.—*Probabilities of last freezing temperatures in spring and first in fall*

[All data from Omaha, Nebr., 1921–70.[1] Elevation 1,040 feet]

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	March 30	April 6	April 14	April 21	May 4.
2 years in 10 later than	March 25	April 1	April 8	April 15	April 29.
5 years in 10 later than	March 14	March 22	March 29	April 5	April 18.
Fall:					
1 year in 10 earlier than	November 8	October 31	October 23	October 13	October 4.
2 years in 10 earlier than	November 13	November 5	October 28	October 18	October 9.
5 years in 10 earlier than	November 24	November 14	November 7	October 28	October 18.

[1] In rural areas of Douglas and Sarpy Counties the corresponding events are about 7 to 10 days later in the spring and 7 to 10 days earlier in the fall.

Low temperature and strong northerly winds that frequently accompany the snow result in huge drifts. The average annual snowfall is about 32 inches, but the amount of snow varies considerably from year to year. The snow cover frequently melts between falls. Snow covers the ground for 46 days in an average winter in Omaha and slightly more in the rural areas.

According to climate records (see table 10), 2 years in 10 have at least four days in July that have a temperature of 102° F. On the other hand, 2 years in 10 the temperature falls to −7° F. or lower on four nights in January. The average annual highest temperature is 101° F., and the average annual lowest is −14° F. The temperature was as high as 114° F. in 1936, and as low as −32° F. in 1884.

The growing season, defined as the number of days between the last freezing temperature in spring and the first in fall, averages about 183 days in Omaha, but only about 167 days in the rural areas. The probabilities of freezing temperatures for Omaha are shown in table 11. The growing season is 7 to 10 days later in spring and 7 to 10 days earlier in fall in rural areas.

Annual evaporation from shallow lakes in the area averages about 42 inches. Approximately 77 percent of the total evaporation occurs between May 1 and October 31.

Water

The ground water in most of the survey area is of good quality, and the supply is generally adequate for domestic use. Large capacity wells for irrigation, industrial, and municipal use can be developed throughout most of the Platte, Elkhorn, and Missouri River Valleys. Elsewhere, the potential for large capacity wells is limited to areas of thick sandstone or to restricted, buried valleys. Deep wells, several hundred feet or more in depth, have been a source of moderately mineralized water for industrial use.

Natural Vegetation

Before the prairies were broken, nearly all of the uplands supported a luxuriant growth of prairie grasses, and most of the valley slopes along the Missouri and Platte Rivers and along the lower course of Big Papillion Creek were forested. Nearly all of the virgin sod was then plowed and used for crops. Most of the forested areas have been cut at least once. The native grass vegetation on uplands consisted primarily of little bluestem, needlegrass, side-oats grama, junegrass, and prairie dropseed. On the flood plains, big bluestem, tall panicgrass, indiangrass, and wild rye were abundant in the better drained areas, and sloughgrass and sedges grew in the poorly drained areas.

Transportation

Douglas and Sarpy Counties have good transportation facilities. The main lines of several railroads traverse the county and provide good connections with grain and livestock terminals in Omaha and terminals outside the survey area at St. Joseph, Kansas City, and Denver. Eppley Airfield is in Douglas County, and most major airlines maintain regular flights. Many smaller airports for light planes are in the survey area.

The area is traversed by Interstate 80 in an east-west direction, and by four federal highways, U.S. Highways 6 and 275 in an east-west direction, and U.S. Highways 73 and 75 in a north-south direction. Highways 92 and 36 also run in an east-west direction.

The rural road system is well developed. Roads generally are on section lines, except in the bluff areas. Many of these are hard surfaced. A few are generally gravelled or covered with crushed limestone. Rural mail routes reach all parts of the survey area.

Manufacturing and Business Services

The nation's largest livestock auction is held at Omaha, 6 days each week. Cattle and hogs are shipped by trucks from nearby feedyards and by rail from areas in western Nebraska and other states. Feeder calves are shipped from Western States and the sandhills of Nebraska. They are purchased and then returned to farms for further growth and fattening. Fattened cattle and hogs are bought by several meatpacking houses in Omaha.

Poultry and dairy products produced on the farm are mostly marketed in Omaha. Grain and feed products not used on the farm are sold to local elevator operators who transport them by truck or rail to Omaha markets. Much of this grain is shipped by barge down the Missouri River to other large terminals. Some of the grain is processed into food products at Omaha. Many businesses produce, service, and sell machinery used in farming.

Trends in Soil Use

The 1959 Nebraska Agricultural Statistics listed 1,290 farms in Douglas County, but by 1971 the number had fallen to 635. Farms in Sarpy County numbered 730 in 1959, and only 515 by 1971. The reduction in the number of farms in both counties is caused partly by the increased acreage of farms, but is mainly caused by the effects of urbanization. More areas are being used for urban expansion and industrialization, particularly in the western part of Douglas County and the northern and northeastern parts of Sarpy County.

Literature Cited

(1) American Association of State Highway Officials.
1961. standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 v., illus.

(2) Klingebiel, A. A., and Montgomery, P. H.
1961. land-capability classification. U.S. Dept. Agr. Handbook 210, 21 pp.

(3) Simonson, Roy W.
1962. soil classification in the united states. Sci. 137: 1027–1034, illus.

(4) United States Department of Agriculture.
1951. soil survey manual. U.S. Dept. Agr. Handbook 18, 503 pp., illus.

(5) ———
1960. soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplements issued in March 1967 and September 1968]

(6) ———
1966. soil survey laboratory data and descriptions for some soils of nebraska. Soil Survey Invest. Rpt. No. 5, 233 pp.

(7) United States Department of Defense.
1968. unified soil classification system for roads, airfields, embankments and foundations. MIL–STD–619B, 30 pp., illus.

Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. The capacity to store water available for use by plants, usually expressed in linear depths of water per unit depth of soil. Commonly defined as the difference between the percentage of soil water at field capacity and the percentage at wilting point. This difference multiplied by the bulk density and divided by 100 gives a value in surface inches of water per inch depth of soil. In this report, the classes of available water capacity for a 60 inch profile, or to a limiting layer are:

Very low	0 to 3 inches
Low	3 to 6 inches
Moderate	6 to 9 inches
High	over 9 inches

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Depth, soil. The total thickness of weathered soil material over mixed sand and gravel or bedrock. In this report the classes of soil depth are as follows:

Very shallow	0 to 10 inches
Shallow	10 to 20 inches
Moderately deep	20 to 40 inches
Deep	more than 40 inches

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Lime. Chemically, lime is calcium oxide (CaO), but its meaning has been extended to include all limestone-derived materials applied to neutralize acid soils. Agricultural lime can be obtained as ground limestone, hydrated lime, or burned lime, with or without magnesium minerals. Basic slag, oystershells, and marl also contain calcium.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Permeability, soil. The quality of a moist soil that enables water or air to move through it. In this survey, permeability applies to that part of the soil below the Ap, or equivalent layer, and above a depth of 60 inches or above bedrock if it is within a depth of 60 inches. Where there is a change of two or more permeability classes within a short vertical distance, the classes and depths will be stated. Classes of soil permeability in inches of water per hour are as follows:

Very slow	less than 0.06
Slow	0.06 to 0.2
Moderately slow	0.20 to 0.6
Moderate	0.6 to 2.0
Moderately rapid	2.0 to 6.0
Rapid	6.0 to 20.0
Very rapid	20.0 and over

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum. Unconsolidated, partly weathered mineral material that accumulates over disintegrating solid rock. Residual material is not soil but is frequently the material in which a soil has formed.

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slope. The degree of deviation of a surface from the horizontal, usually expressed in percent or degrees. In this report, the following slope classes are recognized:

Nearly level	0 to 1 percent
Gently sloping	1 to 3 percent
Moderately sloping	3 to 7 percent
Strongly sloping	7 to 11 percent
Moderately steep	11 to 17 percent
Steep	17 to 30 percent
Very steep	30 to 60 percent

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stratified. Composed of, or arranged in, strata, or layers, such as stratified alluvium. The term is confined to geological material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon; has no depth limit.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at www.section508.gov.

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email Section508@oc.usda.gov. If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the USDA Section 508 Coordination Team.

Nondiscrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

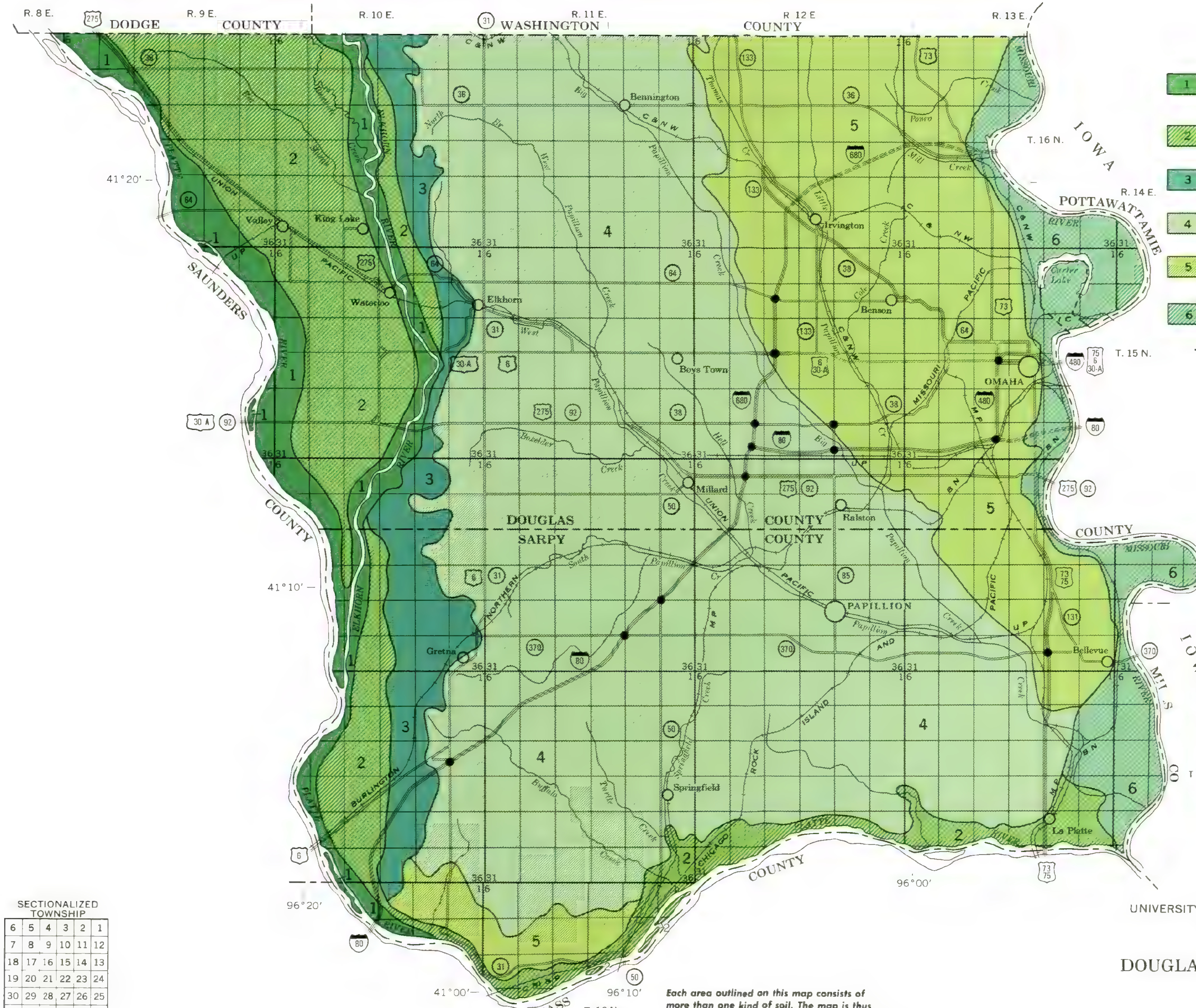
To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.



SOIL ASSOCIATIONS*

1. Cass-Inavale-Wann association: Deep, somewhat excessively drained to somewhat poorly drained, nearly level loamy and sandy soils on bottom land along the Platte and Elkhorn Rivers
2. Gibbon-Eudora-Wabash association: Deep, poorly drained to well-drained, nearly level silty and clayey soils on bottom land along the Platte and Elkhorn Rivers
3. Ponca-Ida association: Deep, well-drained, strongly sloping to steep silty soils on bluffs adjacent to the Elkhorn River Valley
4. Marshall-Ponca association: Deep, well-drained, nearly level to moderately steep silty soils on loess uplands
5. Monona-Ida association: Deep, well-drained, nearly level to very steep silty soils on bluffs adjacent to the Missouri River Valley
6. Albaton-Haynie association: Deep, poorly drained to moderately well drained, nearly level clayey and silty soils on bottom land along the Missouri River

*The texture is that of the surface layer of the major soils.

Compiled 1973

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

UNIVERSITY OF NEBRASKA, CONSERVATION AND SURVEY DIVISION

GENERAL SOIL MAP

DOUGLAS AND SARPY COUNTIES, NEBRASKA

Scale 1:190,080

1 0 1 2 3 4 Miles

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which it belongs. Management of each soil is defined in the description of the capability unit, range site, and windbreak suitability group to which it is assigned. Other information is given in tables as follows:

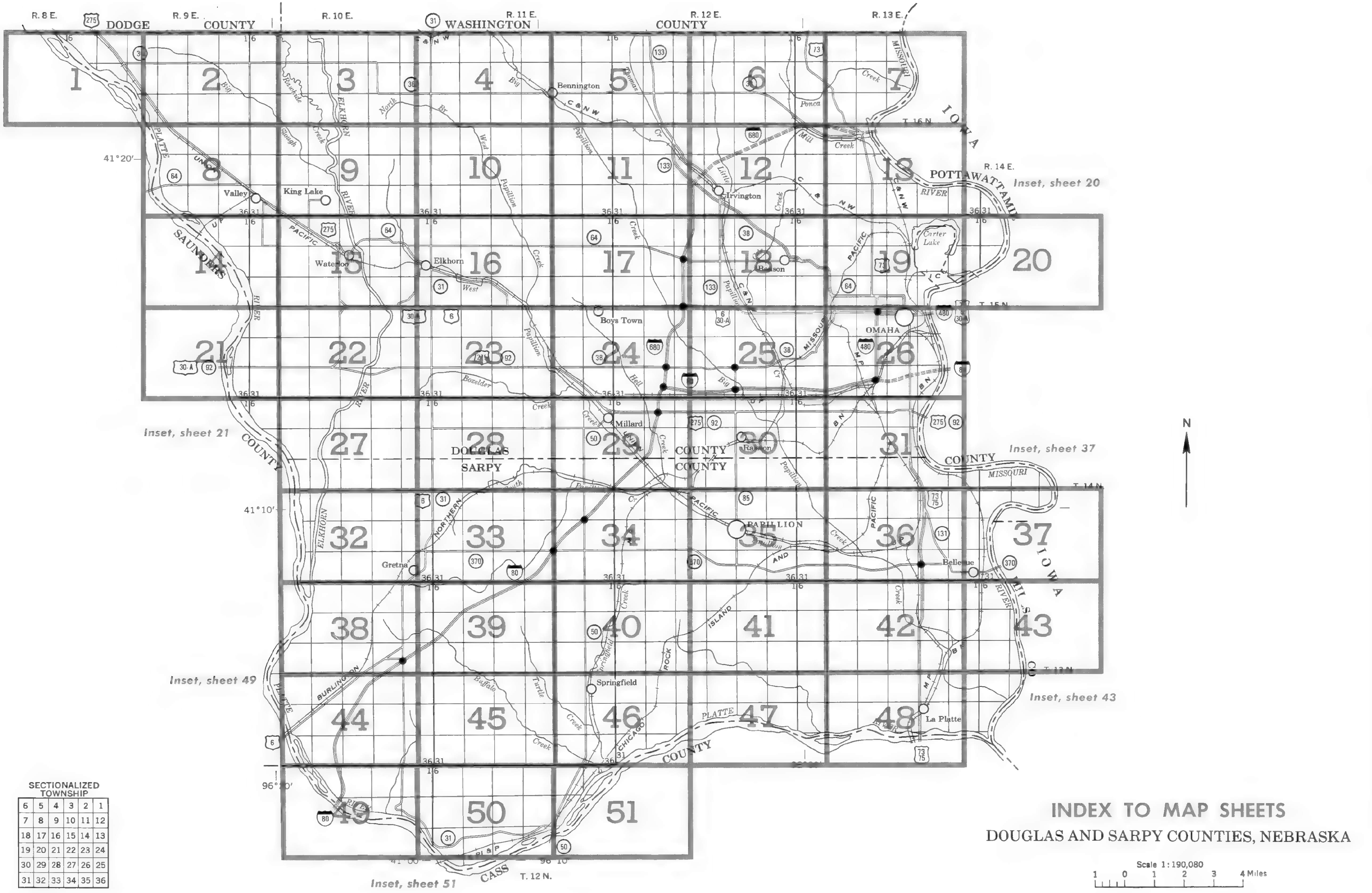
Acreage and extent, table 1, page 8.
Predicted yields, table 2, page 43.
Windbreaks. table 3, page 48.
Engineering uses of the soils, tables 6, 7, and 8, pages 56 through 71.

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak suitability group
			Symbol	Page	Name	Page	Name
Ab	Albaton silt loam, overwash----------	9	IIIw-2	38	Silty Overflow	45	Moderately Wet
Ac	Albaton silty clay------------------	7	IIIw-1	37	Clayey Overflow	45	Moderately Wet
Af	Alda fine sandy loam-----------------	9	IIIw-6	38	Subirrigated	44	Moderately Wet
Ag	Alda very fine sandy loam------------	10	IIIw-4	38	Subirrigated	44	Moderately Wet
Ca	Carr fine sandy loam-----------------	10	IIs-6	36	Sandy Lowland	45	Sandy
Cc	Cass fine sandy loam-----------------	11	IIs-6	36	Sandy Lowland	45	Sandy
Cd	Cass fine sandy loam, loamy substratum----------------------------	11	IIs-6	36	Sandy Lowland	45	Sandy
Ce	Cass very fine sandy loam------------	11	I-1	34	Sandy Lowland	45	Silty to Clayey
Cg	Colo silty clay loam-----------------	12	IIw-4	36	Clayey Overflow	45	Moderately Wet
Ck	Colo and Kennebec soils--------------	12	IIw-3	35	--------	--	Moderately Wet
	Colo soil----------------------	--	----	--	Clayey Overflow	45	--------
	Kennebec soil------------------	--	----	--	Silty Lowland	45	--------
Cm	Cut and fill land--------------------	12	----	--	--------	--	--------
DcE	Dickinson soils, 11 to 17 percent slopes----------------------------	12	VIe-3	40	Sandy	46	Sandy
Ed	Eudora silt loam---------------------	13	I-1	34	Silty Overflow	45	Silty to Clayey
Ga	Gibbon loamy sand, overwash----------	13	IIw-6	36	Subirrigated	44	Moderately Wet
Gb	Gibbon silt loam---------------------	14	IIw-4	36	Subirrigated	44	Moderately Wet
Gc	Gibbon silty clay loam---------------	14	IIw-4	36	Subirrigated	44	Moderately Wet
Gs	Gibbon-Slickspots complex------------	14	IVs-1	40	--------	--	Moderately Saline or Alkali
	Gibbon soil--------------------	--	----	--	Subirrigated	44	--------
	Slickspots---------------------	--	----	--	Saline Lowland	45	--------
Gu	Gullied land-------------------------	14	VIIe-1	41	Thin Loess	46	Undesirable
Ha	Haynie silt loam---------------------	15	I-1	34	Silty Lowland	45	Silty to Clayey
IdD2	Ida silt loam, 7 to 17 percent slopes, eroded--------------------	15	IVe-9	39	Limy Upland	46	Silty to Clayey
IdE	Ida silt loam, 17 to 30 percent slopes----------------------------	15	VIe-9	41	Limy Upland	46	Undesirable
IdE2	Ida silt loam, 17 to 30 percent slopes, eroded--------------------	16	VIe-9	41	Limy Upland	46	Undesirable
Im	Inavale loamy fine sand--------------	16	IIIe-5	36	Sandy Lowland	45	Sandy
In	Inavale loamy fine sand, hummocky----	16	VIe-5	48	Sandy Lowland	45	Very Sandy
JuB	Judson silt loam, 3 to 7 percent slopes---------------------------	17	IIe-1	34	Silty	46	Silty to Clayey
Ke	Kennebec silt loam, occasionally flooded--------------------------	17	IIw-3	35	Silty Overflow	45	Moderately Wet
Le	Lex soils, noncalcareous variant-----	18	IIIw-4	38	Subirrigated	44	Moderately Wet
Ls	Luton silt loam, overwash------------	19	IIIw-2	38	Silty Overflow	45	Moderately Wet
Lt	Luton silty clay loam----------------	19	IIIw-1	37	Clayey Overflow	45	Moderately Wet
Lu	Luton silty clay---------------------	18	IIIw-1	37	Clayey Overflow	45	Moderately Wet
MaA	Marshall silty clay loam, 0 to 1 percent slopes-------------------	19	I-1	34	Silty	46	Silty to Clayey
MaB	Marshall silty clay loam, 1 to 3 percent slopes-------------------	19	IIe-1	34	Silty	46	Silty to Clayey

Map symbol	Mapping unit	Page	Capability unit Symbol	Capability unit Page	Range site Name	Range site Page	Windbreak suitability group Name
MaC	Marshall silty clay loam, 3 to 7 percent slopes	20	IIe-1	34	Silty	46	Silty to Clayey
MaC2	Marshall silty clay loam, 3 to 7 percent slopes, eroded	20	IIIe-8	36	Silty	46	Silty to Clayey
MaD	Marshall silty clay loam, 7 to 11 percent slopes	20	IIIe-1	36	Silty	46	Silty to Clayey
MeD2	Marshall-Ponca silty clay loams, 7 to 11 percent slopes, eroded	21	IIIe-8	36	Silty	46	Silty to Clayey
MfE	Marshall and Ponca soils, 11 to 17 percent slopes	21	IVe-1	38	Silty	46	Silty to Clayey
MfE2	Marshall and Ponca soils, 11 to 17 percent slopes, eroded	21	IVe-8	38	Silty	46	Silty to Clayey
MoA	Monona silt loam, 0 to 1 percent slopes	23	I-1	34	Silty	46	Silty to Clayey
MoB	Monona silt loam, 1 to 3 percent slopes	23	IIe-1	34	Silty	46	Silty to Clayey
MoC	Monona silt loam, 3 to 7 percent slopes	23	IIe-1	34	Silty	46	Silty to Clayey
MoC2	Monona silt loam, 3 to 7 percent slopes, eroded	23	IIIe-8	36	Silty	46	Silty to Clayey
MoD	Monona silt loam, 7 to 11 percent slopes	23	IIIe-1	36	Silty	46	Silty to Clayey
MoD2	Monona silt loam, 7 to 11 percent slopes, eroded	23	IIIe-8	36	Silty	46	Silty to Clayey
MoE	Monona silt loam, 11 to 17 percent slopes	23	IVe-1	38	Silty	46	Silty to Clayey
MsE2	Monona and Ida silt loams, 11 to 17 percent slopes, eroded	24	IVe-8	38	-----	--	Silty to Clayey
	Monona soil	--	----	--	Silty	46	--------
	Ida soil	--	----	--	Limy Upland	46	--------
MsF	Monona and Ida silt loams, 17 to 30 percent slopes	24	VIe-1	40	-----	--	Undesirable
	Monona soil	--	----	--	Silty	46	--------
	Ida soil	--	----	--	Limy Upland	46	--------
MsF2	Monona and Ida silt loams, 17 to 30 percent slopes, eroded	24	VIe-8	40	-----	--	Undesirable
	Monona soil	--	----	--	Silty	46	--------
	Ida soil	--	----	--	Limy Upland	46	--------
MsG	Monona and Ida silt loams, 30 to 60 percent slopes	24	VIIe-1	41	-----	--	Undesirable
	Monona soil	--	-----	--	Silty	46	--------
	Ida soil	--	----	--	Limy Upland	46	--------
On	Onawa silty clay	25	IIw-1	35	Clayey Overflow	45	Moderately Wet
Pa	Percival silty clay	25	IIw-1	35	Clayey Overflow	45	Moderately Wet
Pb	Pits and dumps	25	VIIIs-1	41	-----	--	Undesirable
Pc	Platte soils	27	IVw-4	39	Subirrigated	44	Moderately Wet
PdD2	Ponca and Ida silt loams, 7 to 11 percent slopes, eroded	27	IIIe-8	36	-----	--	Silty to Clayey
	Ponca soil	--	----	--	Silty	46	--------
	Ida soil	--	----	--	Limy Upland	46	--------

Map symbol	Mapping unit	Page	Capability unit Symbol	Capability unit Page	Range site Name	Range site Page	Windbreak suitability group Name
PdE2	Ponca and Ida silt loams, 11 to 17 percent slopes, eroded	27	IVe-8	38	-----	--	Silty to Clayey
	Ponca soil	--	----	--	Silty	46	--------
	Ida soil	--	----	--	Limy Upland	46	--------
Ra	Riverwash	28	VIIIs-1	41	-----	--	Undesirable
Rk	Rock land	28	VIIs-3	41	Savannah	45	Undesirable
Rn	Rough broken land, loess	28	VIIe-1	41	Thin Loess	46	Undesirable
Sd	Sandy alluvial land	28	VIw-7	41	Subirrigated	44	Undesirable
Sp	Sarpy fine sand	29	VIs-6	41	Sandy Lowland	45	Very Sandy
Ss	Silty alluvial land	29	VIw-7	41	Silty Overflow	45	Undesirable
StE2	Steinauer clay loam, 11 to 30 percent slopes, eroded	30	VIe-9	41	Limy Upland	46	Undesirable
Wb	Wabash silt loam	31	IIIw-2	38	Silty Overflow	45	Moderately Wet
Wc	Wabash silty clay	31	IIIw-1	37	Clayey Overflow	45	Moderately Wet
Wm	Wann fine sandy loam	32	IIw-6	36	Subirrigated	44	Moderately Wet
Wt	Wet alluvial land	32	Vw-7	40	Wet Land	44	Undesirable

U. S. GOVERNMENT PRINTING OFFICE : 1975 O - 534-869



INDEX TO MAP SHEETS
DOUGLAS AND SARPY COUNTIES, NEBRASKA

SOIL LEGEND

Each soil symbol consists of two or three letters; for example Ab, Ac or IdE. If slope is given in the soil name, the third letter A, B, C, D, E, F or G indicates the slope class. Symbols without a slope letter are those of nearly level soils or land types. A final number 2 in the symbol indicates that the soil is eroded.

SYMBOL	NAME
Ab	Albaton silt loam, overwash
Ac	Albaton silty clay
Af	Alda fine sandy loam
Ag	Alda very fine sandy loam
Ca	Carr fine sandy loam
Cc	Cass fine sandy loam
Cd	Cass fine sandy loam, loamy substratum
Ce	Cass very fine sandy loam
Cg	Colo silty clay loam
Ck	Colo and Kennebec soils
Cm	Cut and fill land
DcE	Dickinson soils, 11 to 17 percent slopes
Ea	Eudora silt loam
Ga	Gibbon loamy sand, overwash
Gb	Gibbon silt loam
Gc	Gibbon silty clay loam
Gs	Gibbon-Slickspots complex
Gu	Gullied land
Ha	Haynie silt loam
IdD2	Ida silt loam, 7 to 17 percent slopes, eroded
IdE	Ida silt loam, 17 to 30 percent slopes
IdE2	Ida silt loam, 17 to 30 percent slopes, eroded
Im	Inavale loamy fine sand
In	Inavale loamy fine sand, hummocky
JuB	Judson silt loam, 3 to 7 percent slopes
Ke	Kennebec silt loam, occasionally flooded
Le	Lex soils, noncalcareous variant
Ls	Luton silt loam, overwash
Lt	Luton silty clay loam
Lu	Luton silty clay
MaA	Marshall silty clay loam, 0 to 1 percent slopes
MaB	Marshall silty clay loam, 1 to 3 percent slopes
MaC	Marshall silty clay loam, 3 to 7 percent slopes
MaC2	Marshall silty clay loam, 3 to 7 percent slopes, eroded
MaD	Marshall silty clay loam, 7 to 11 percent slopes
MeD2	Marshall-Ponca silty clay loams, 7 to 11 percent slopes, eroded
MfE	Marshall and Ponca soils, 11 to 17 percent slopes
MfE2	Marshall and Ponca soils, 11 to 17 percent slopes, eroded
MoA	Monona silt loam, 0 to 1 percent slopes
MoB	Monona silt loam, 1 to 3 percent slopes
MoC	Monona silt loam, 3 to 7 percent slopes
MoC2	Monona silt loam, 3 to 7 percent slopes, eroded
MoD	Monona silt loam, 7 to 11 percent slopes
MoD2	Monona silt loam, 7 to 11 percent slopes, eroded
MoE	Monona silt loam, 11 to 17 percent slopes
MsE2	Monona and Ida silt loams, 11 to 17 percent slopes, eroded
MsF	Monona and Ida silt loams, 17 to 30 percent slopes
MsF2	Monona and Ida silt loams, 17 to 30 percent slopes, eroded
MsG	Monona and Ida silt loams, 30 to 60 percent slopes
On	Onawa silty clay
Pa	Percival silty clay
Pb	Pits and dumps
Pc	Platte soils
PdD2	Ponca and Ida silt loams, 7 to 11 percent slopes, eroded
PdE2	Ponca and Ida silt loams, 11 to 17 percent slopes, eroded
Ra	Riverwash
Rk	Rock land
Rn	Rough broken land, loess
Sd	Sandy alluvial land
Sp	Sarpy fine sand
Ss	Silty alluvial land
StE2	Steinauer clay loam, 11 to 30 percent slopes, eroded
Wb	Wabash silt loam
Wc	Wabash silty clay
Wm	Wann fine sandy loam
Wt	Wet alluvial land

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry (QU.)

Gravel pit (G.P.)

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Limit of soil survey
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
- Unclassified

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Well, irrigation

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

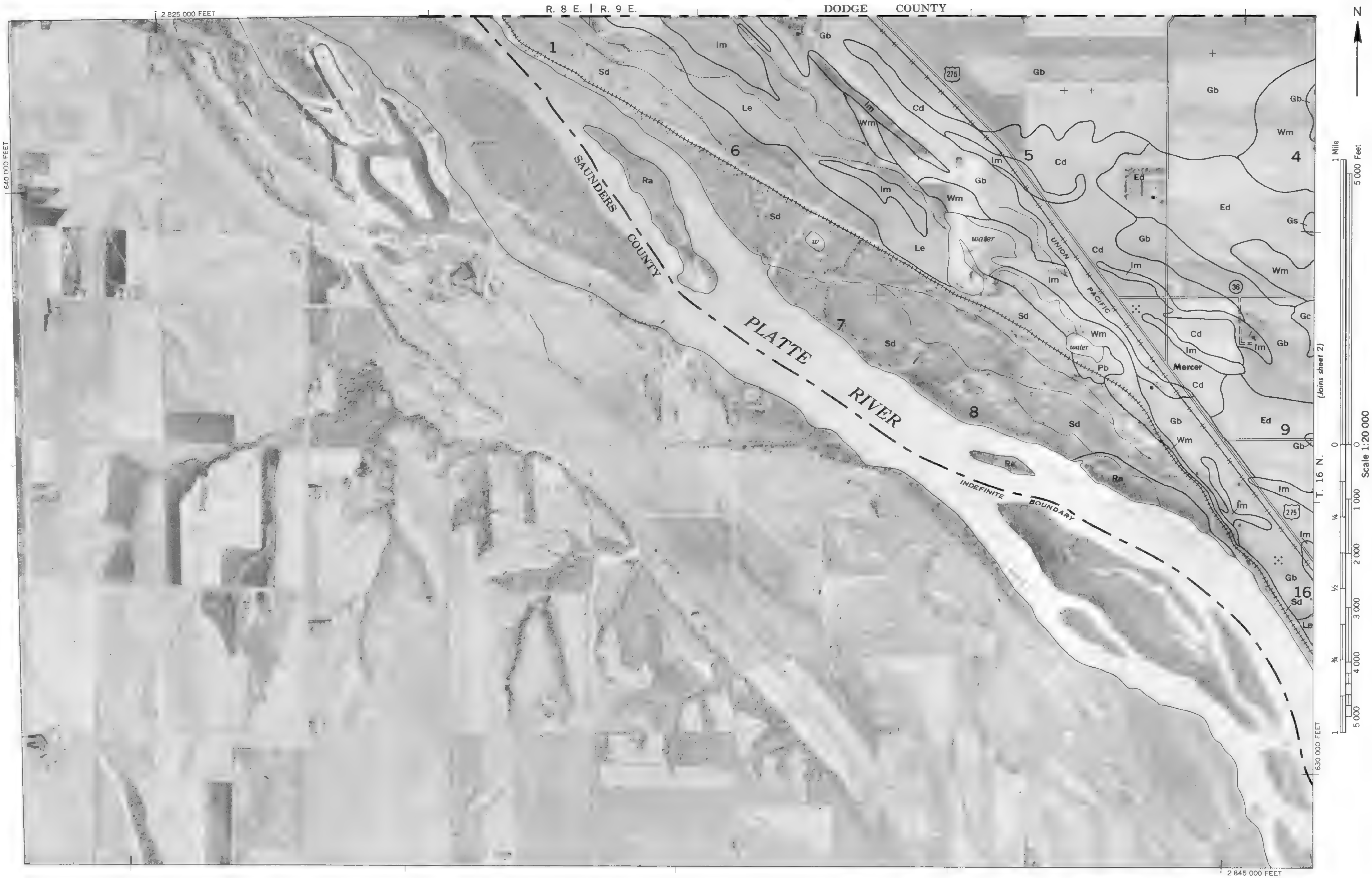
Short steep slope

Prominent peak

Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness: Stony, Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Glacial till
- Saline spot
- Loveland loess

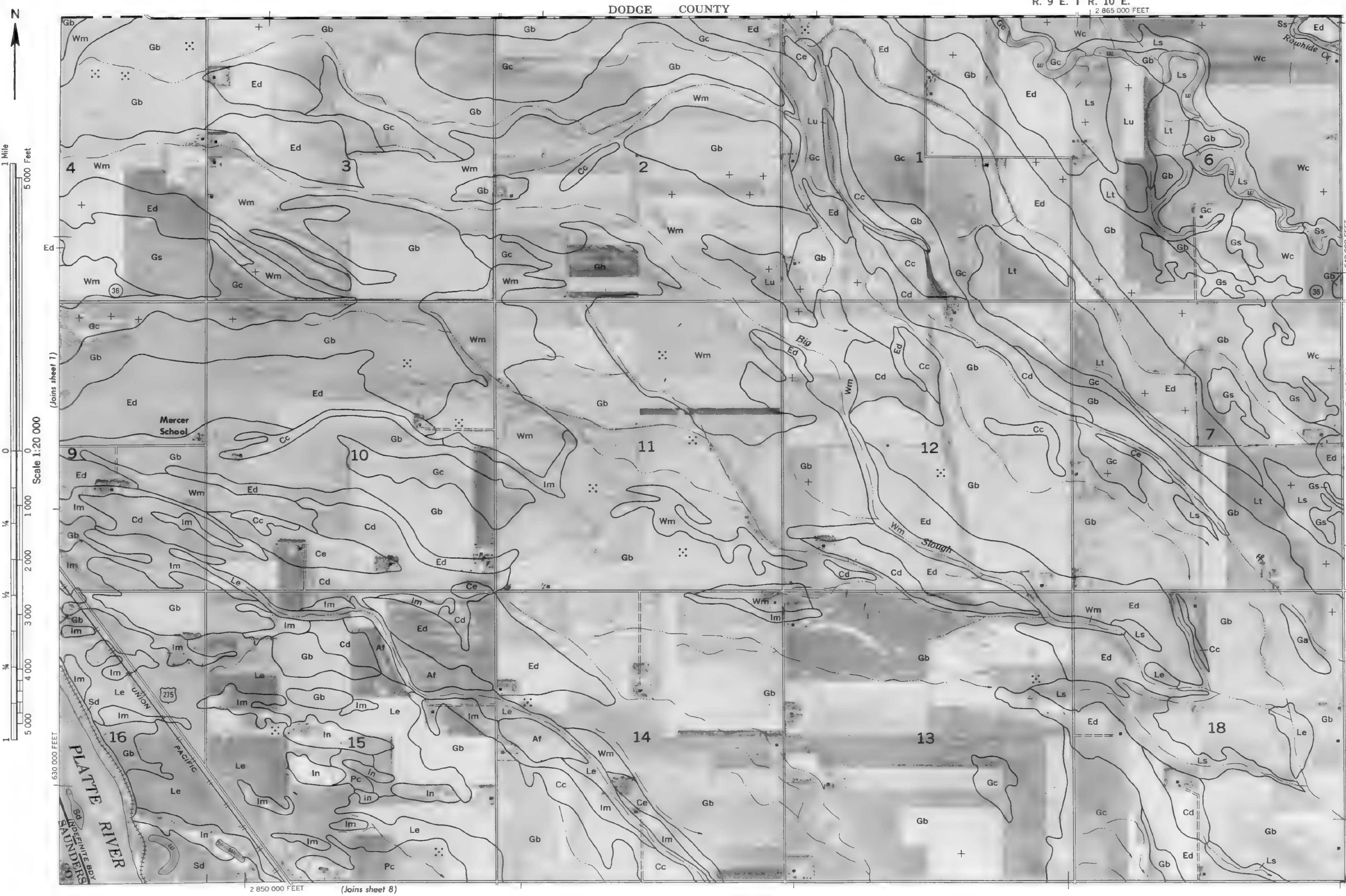


DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 1

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

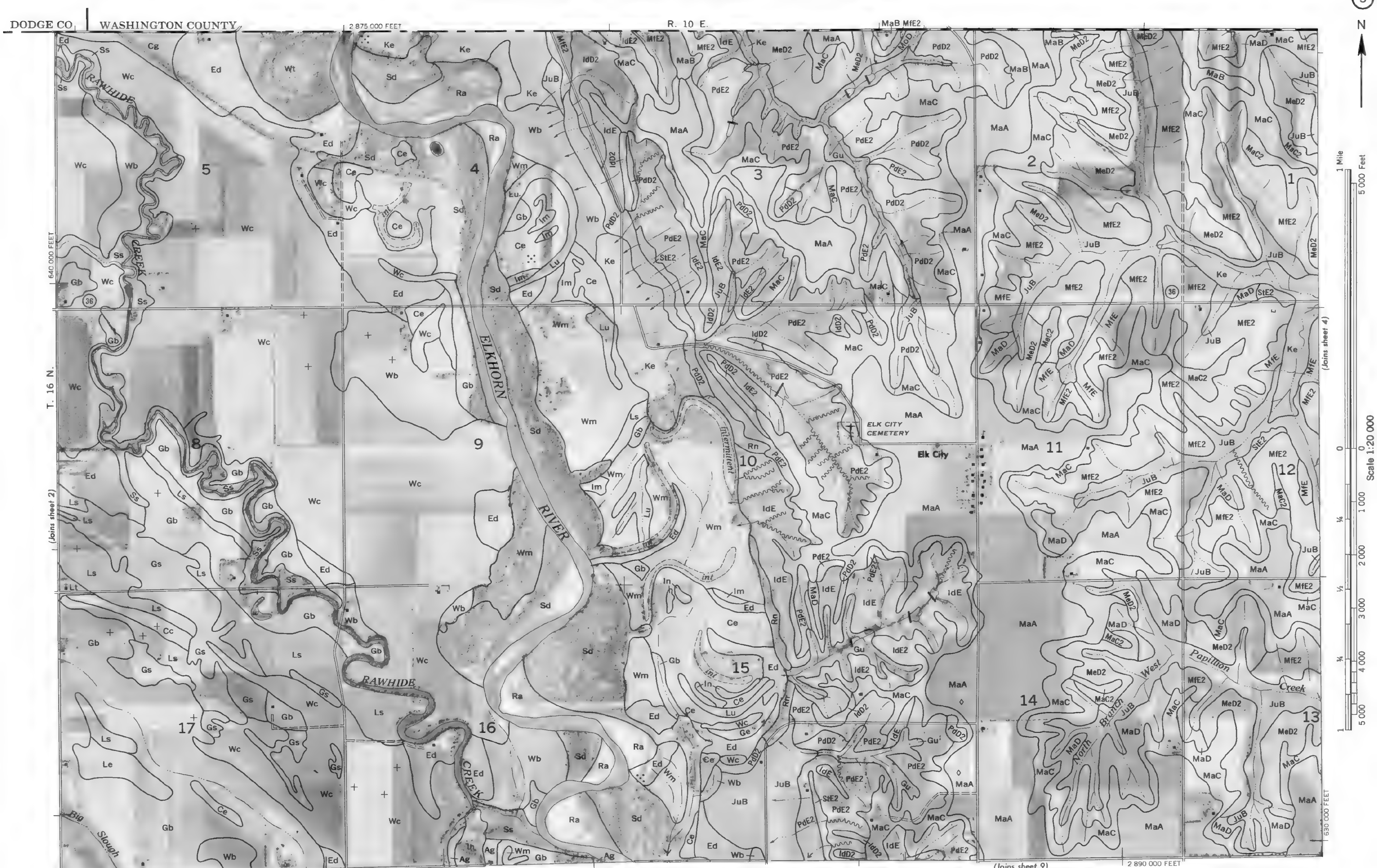
Land division corners are approximately positioned on this map



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.



DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 3

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map

DOUGLAS AND SARPY COUNTIES, NEBRASKA — SHEET NUMBER 4

Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

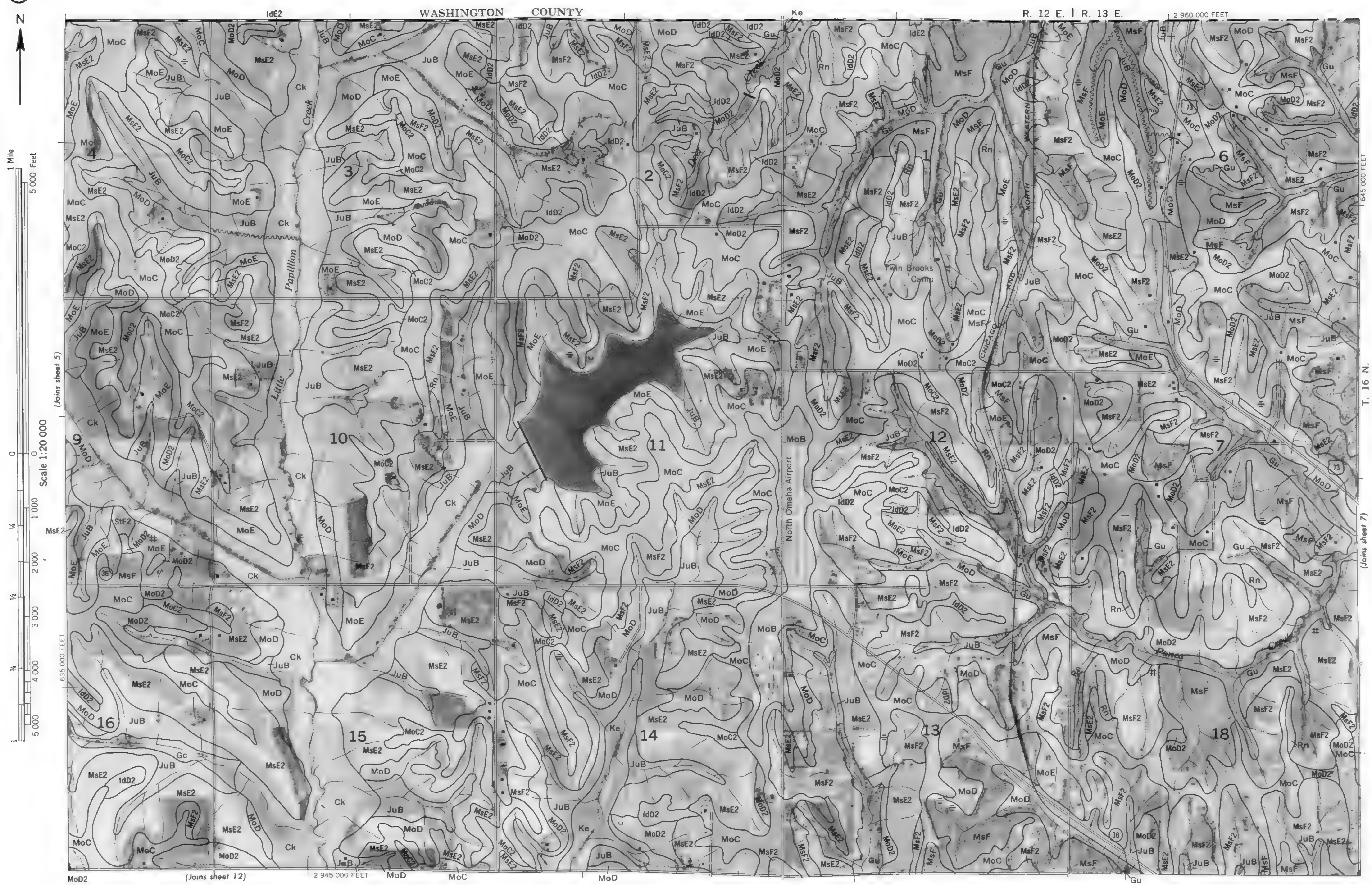
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 4

5

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 5

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone
Land division corners are approximately positioned on this map



DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 6

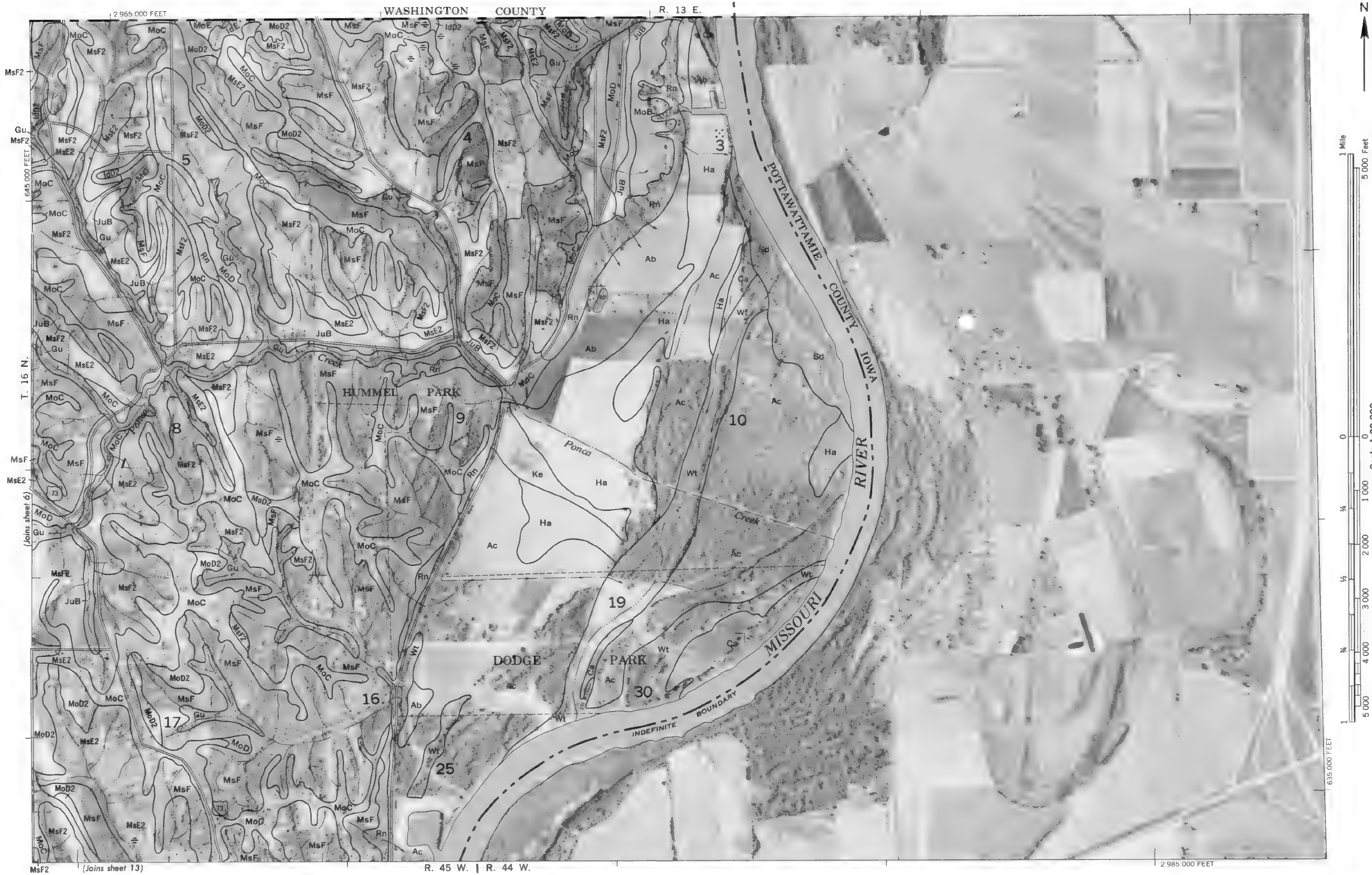
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

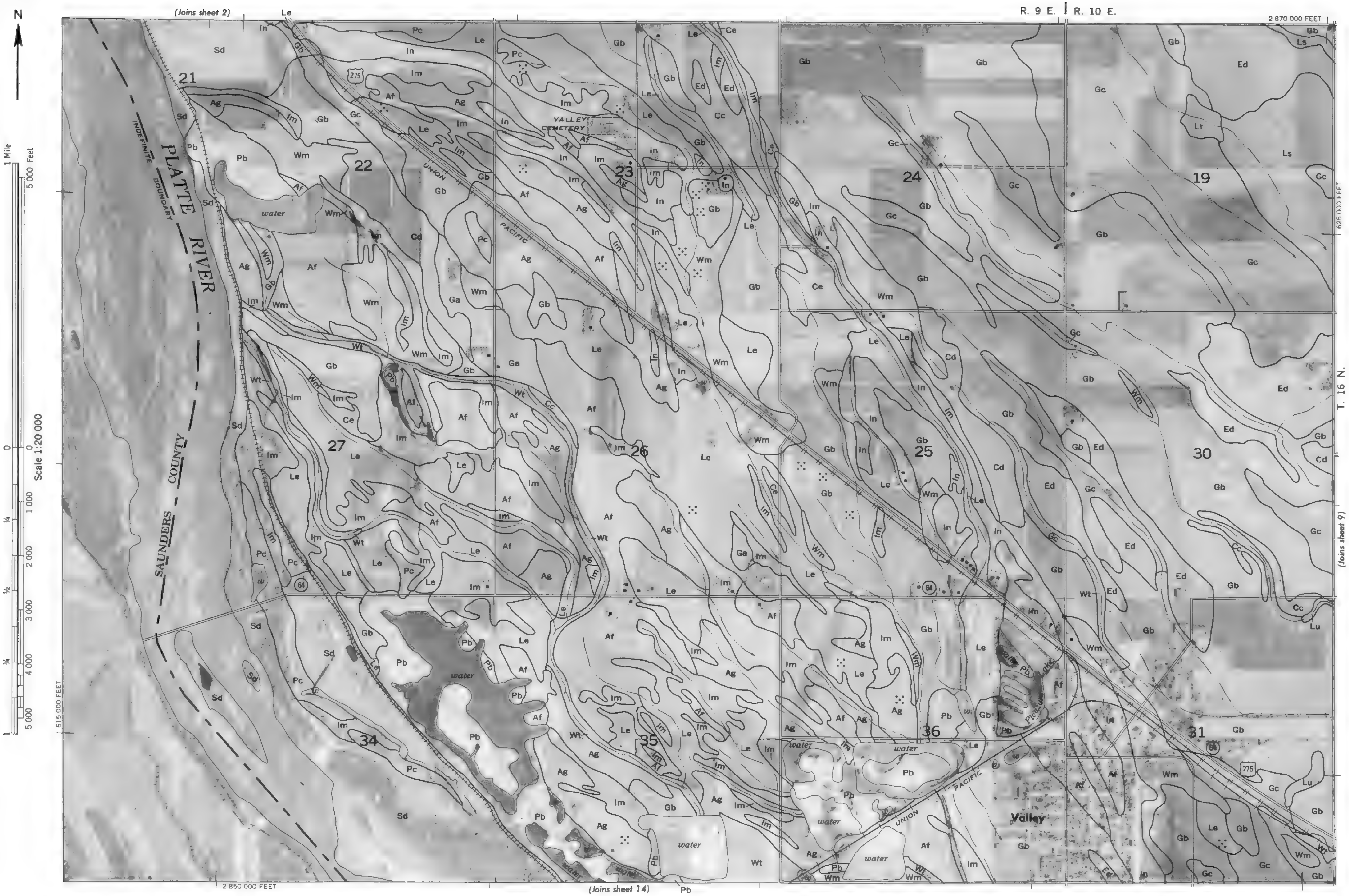
Land division corners are approximately positioned on this map

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 7

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map



DOUGLAS AND SARPY COUNTIES, NEBRASKA — SHEET NUMBER 8



Land division corners are approximately positioned on this map.

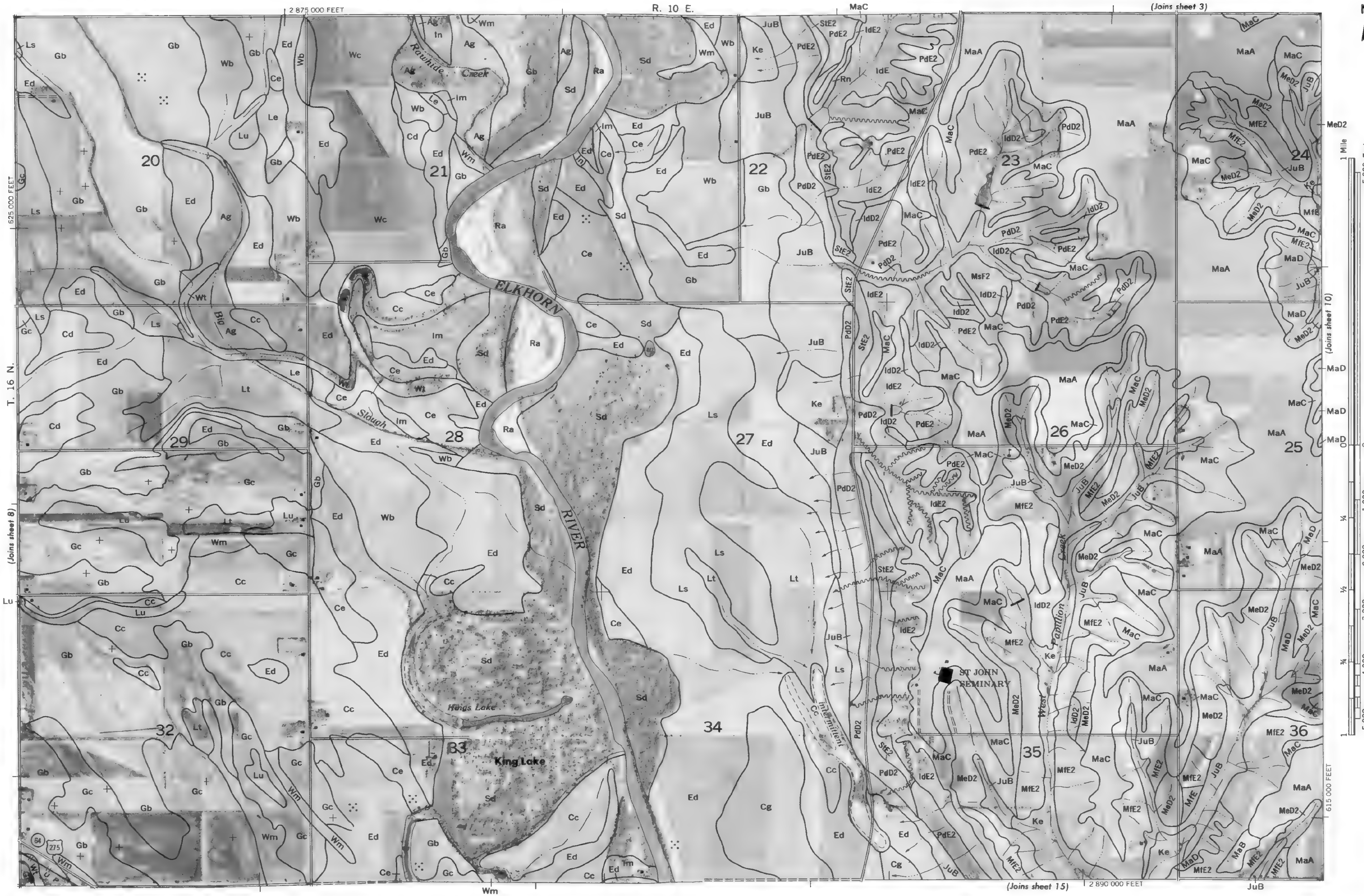
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

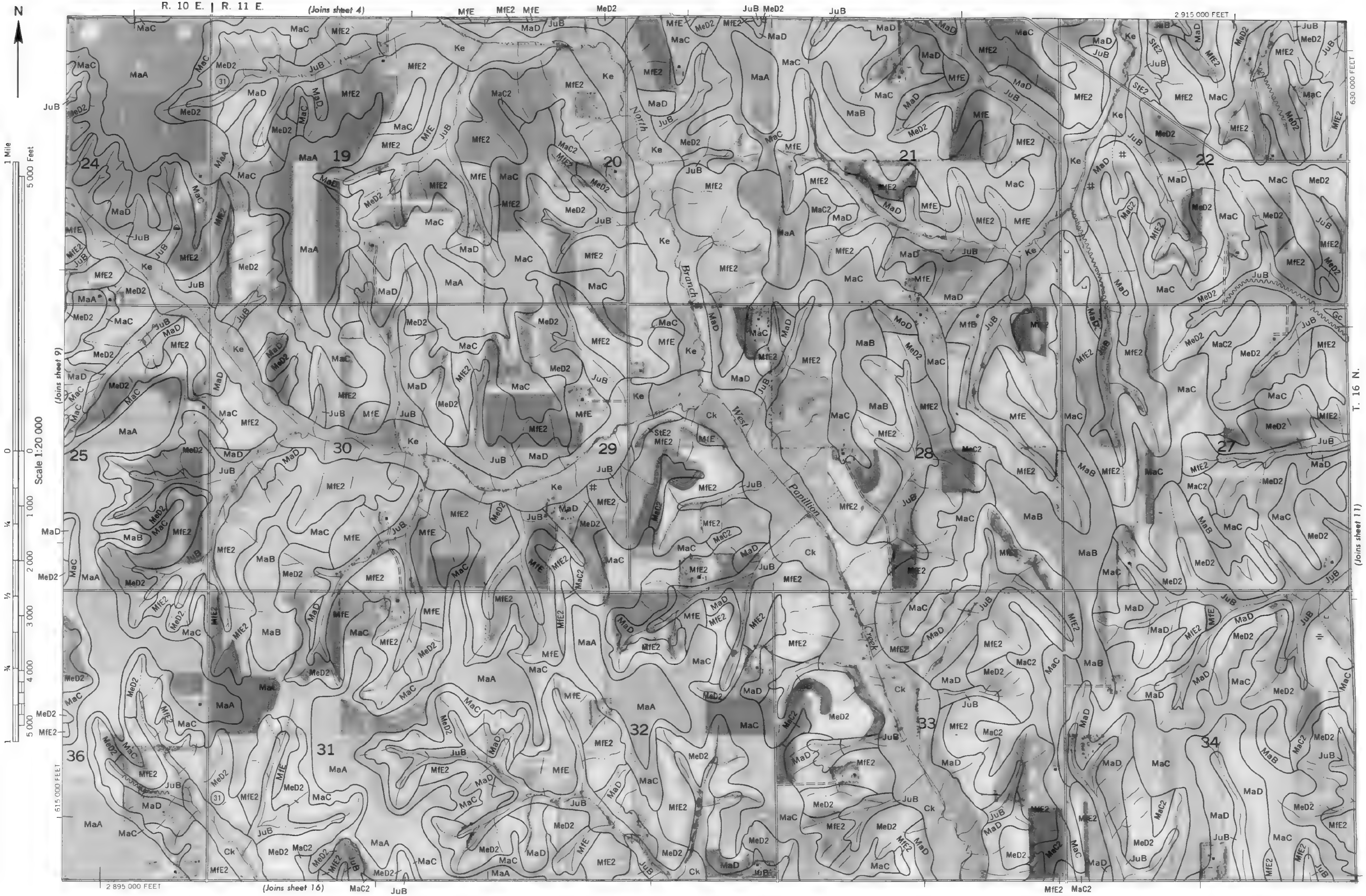
DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 8

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 9

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map



DOUGLAS AND SARPY COUNTIES, NEBRASKA — SHEET NUMBER 10



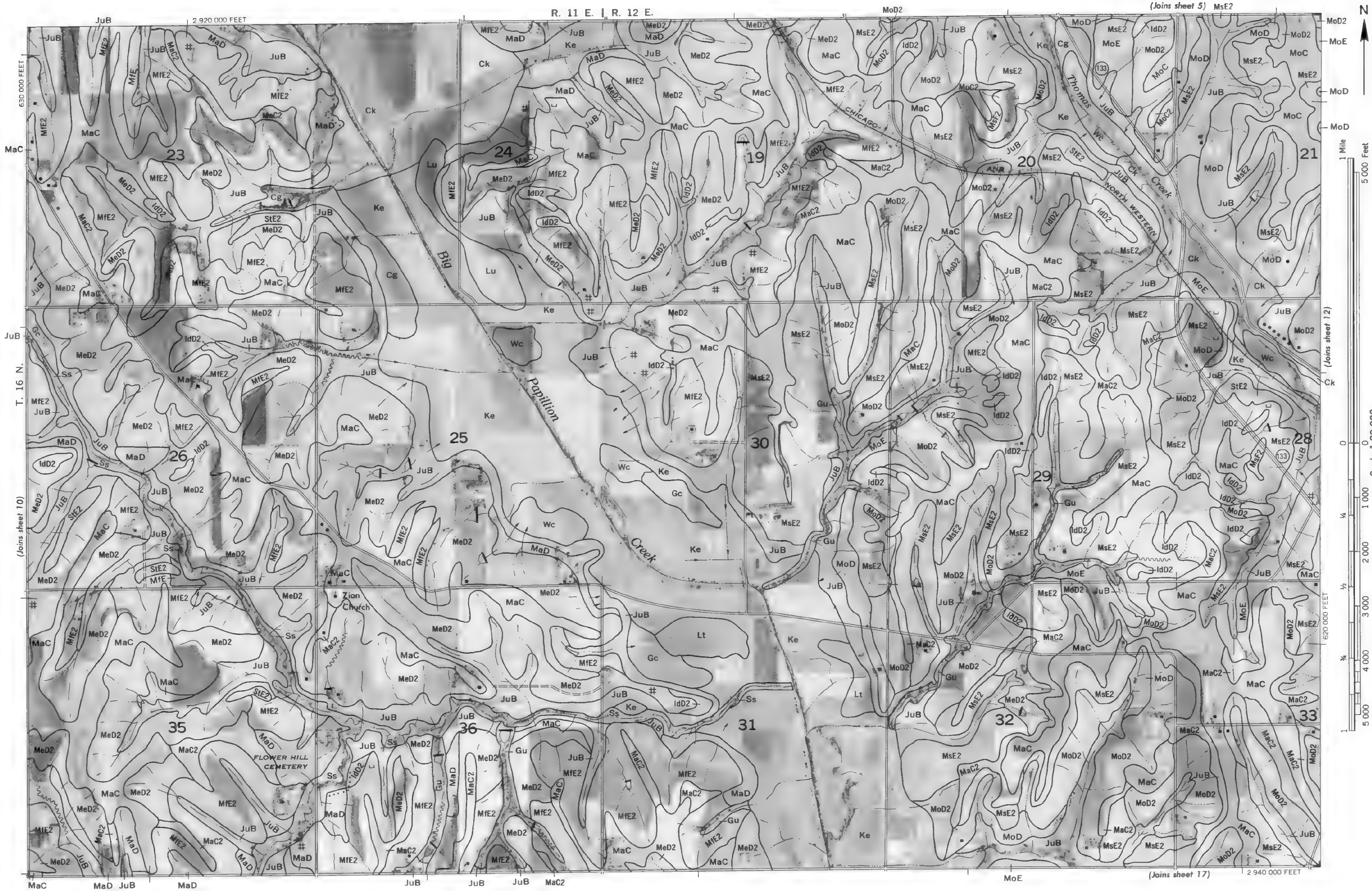
Land division corners are approximately positioned on this map

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 11

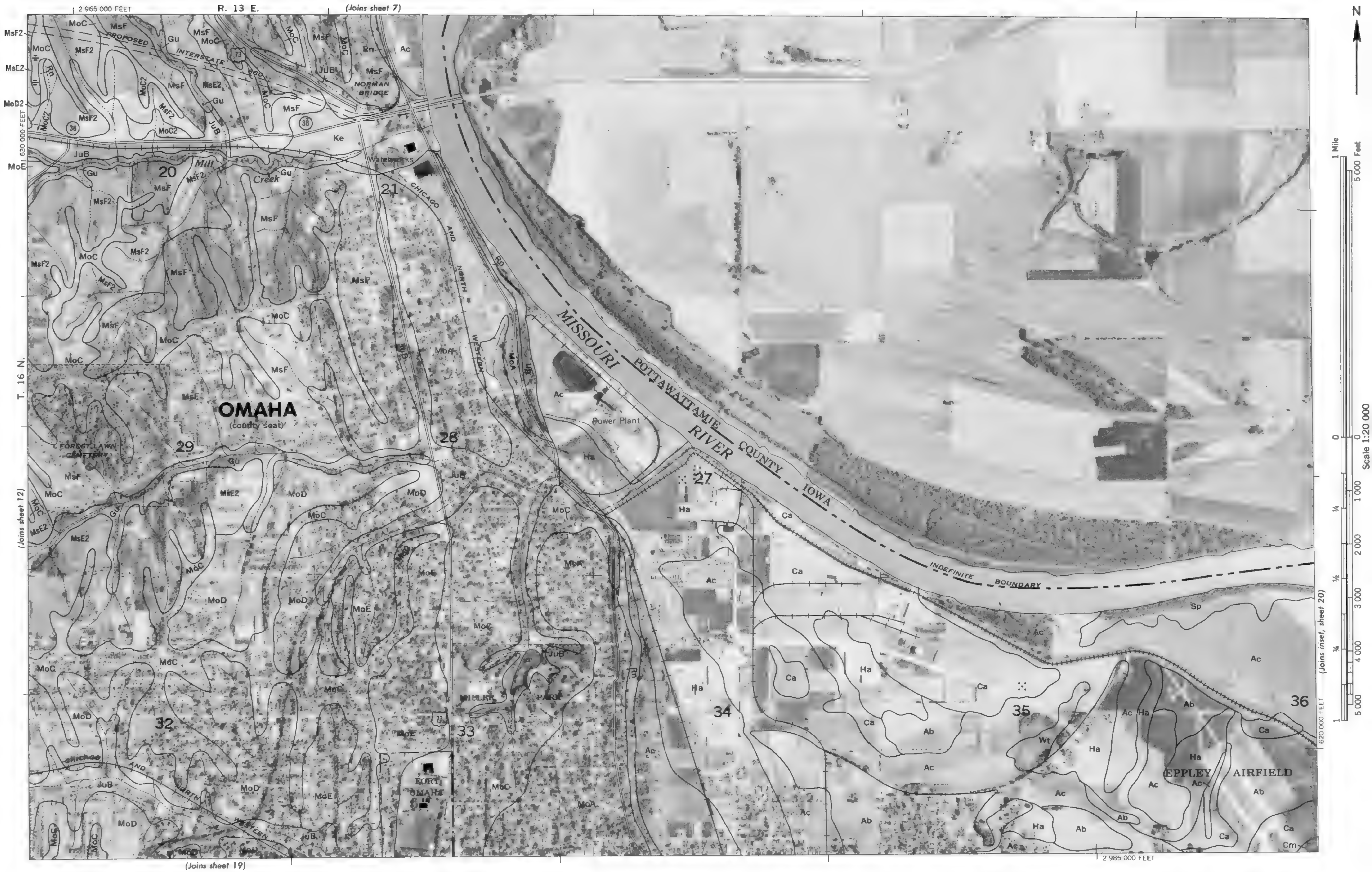
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone
Land division corners are approximately positioned on this map



Land division corners are approximately positioned on this map.

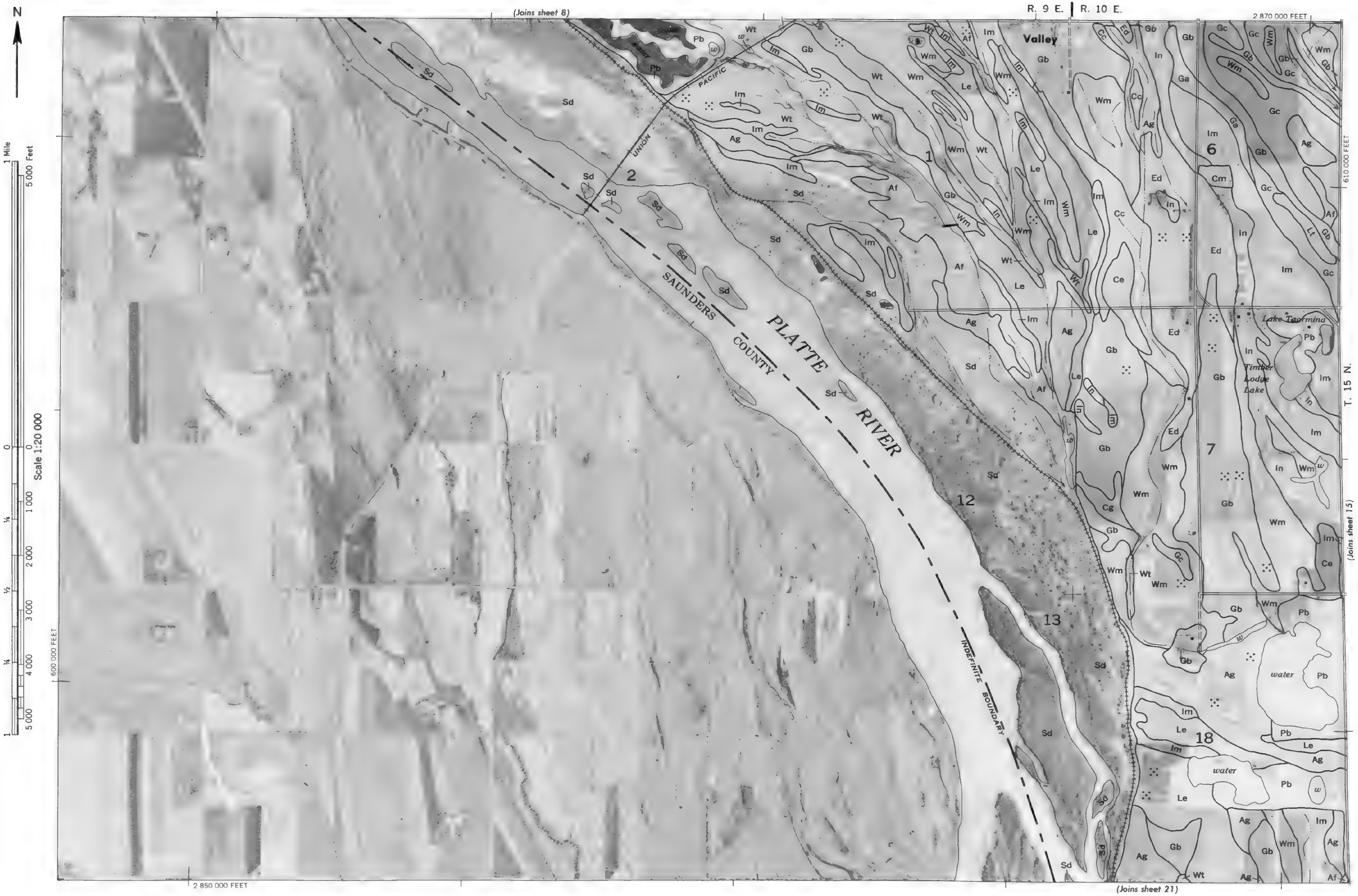
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.



DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 13

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

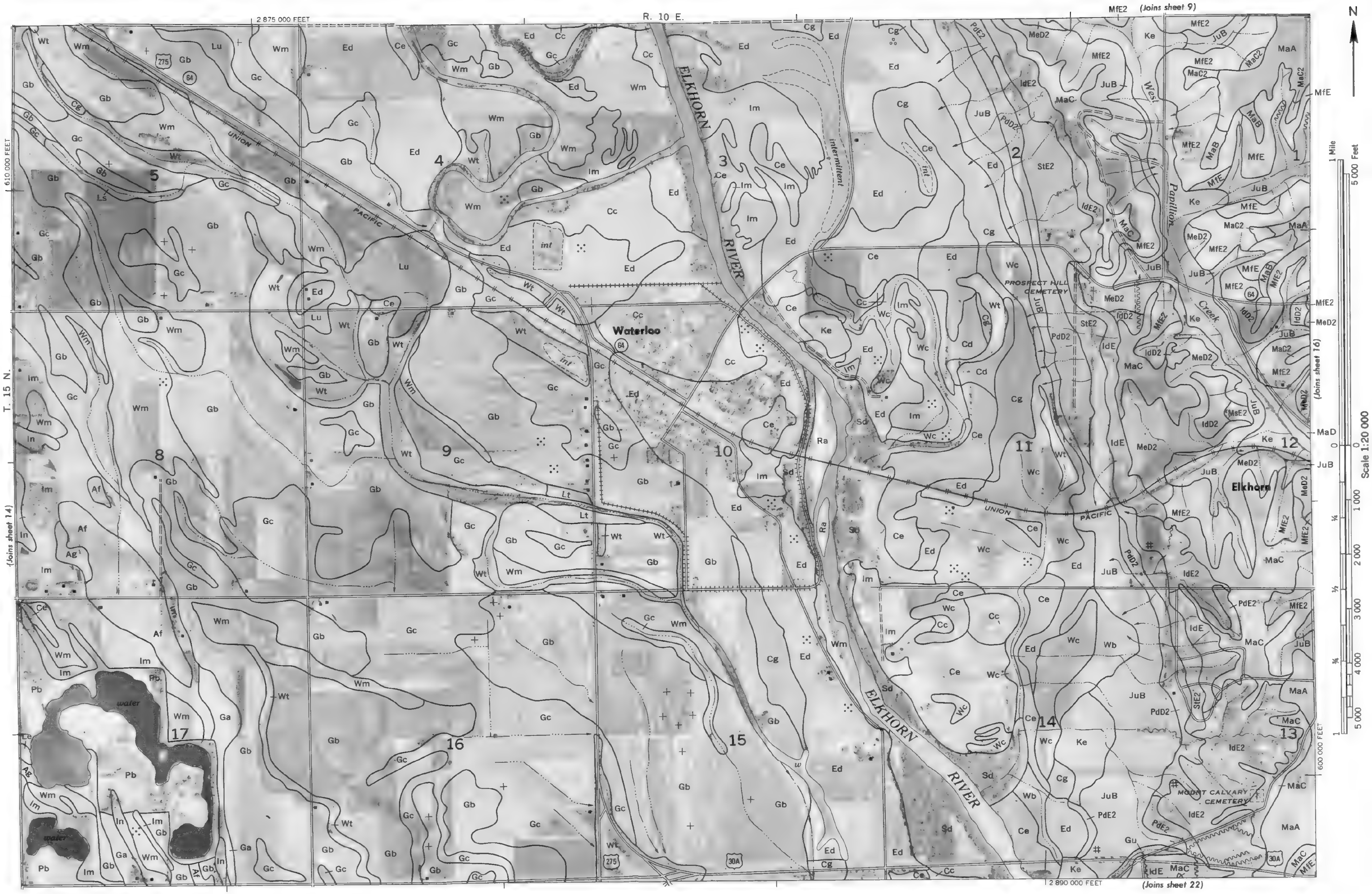
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 14

15

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 15

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map



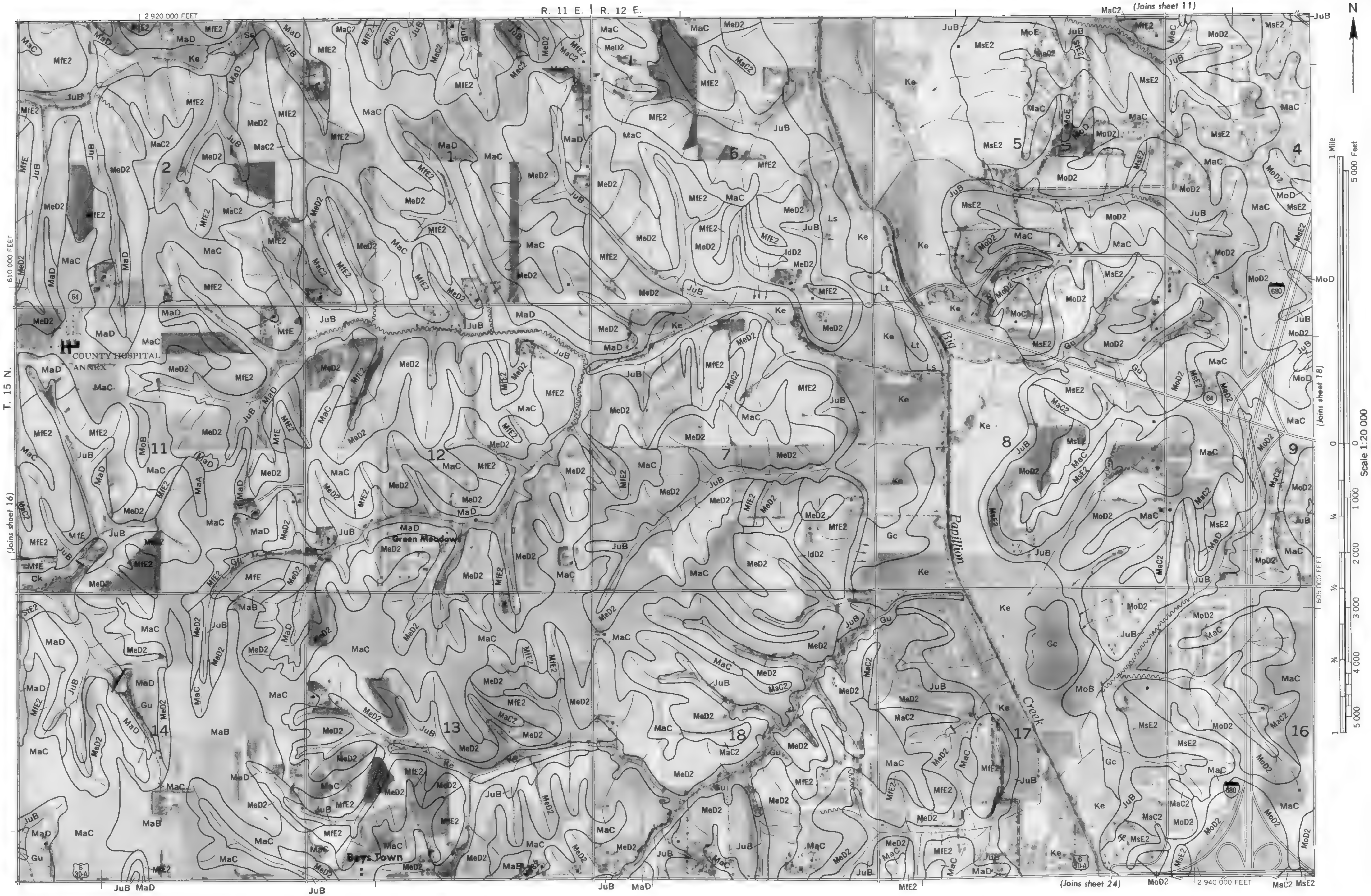
Land division corners are approximately positioned on this map

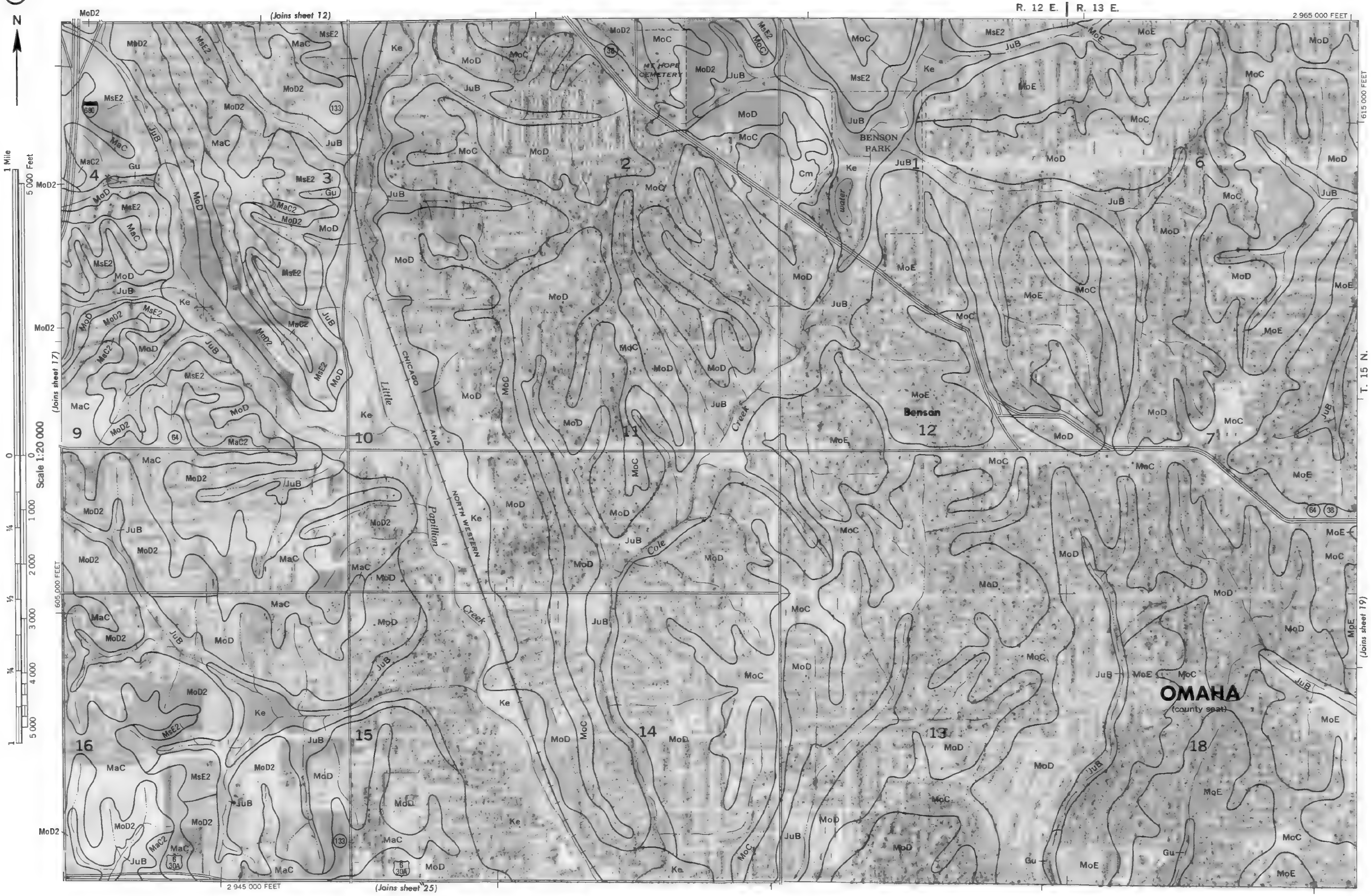
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 17

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map

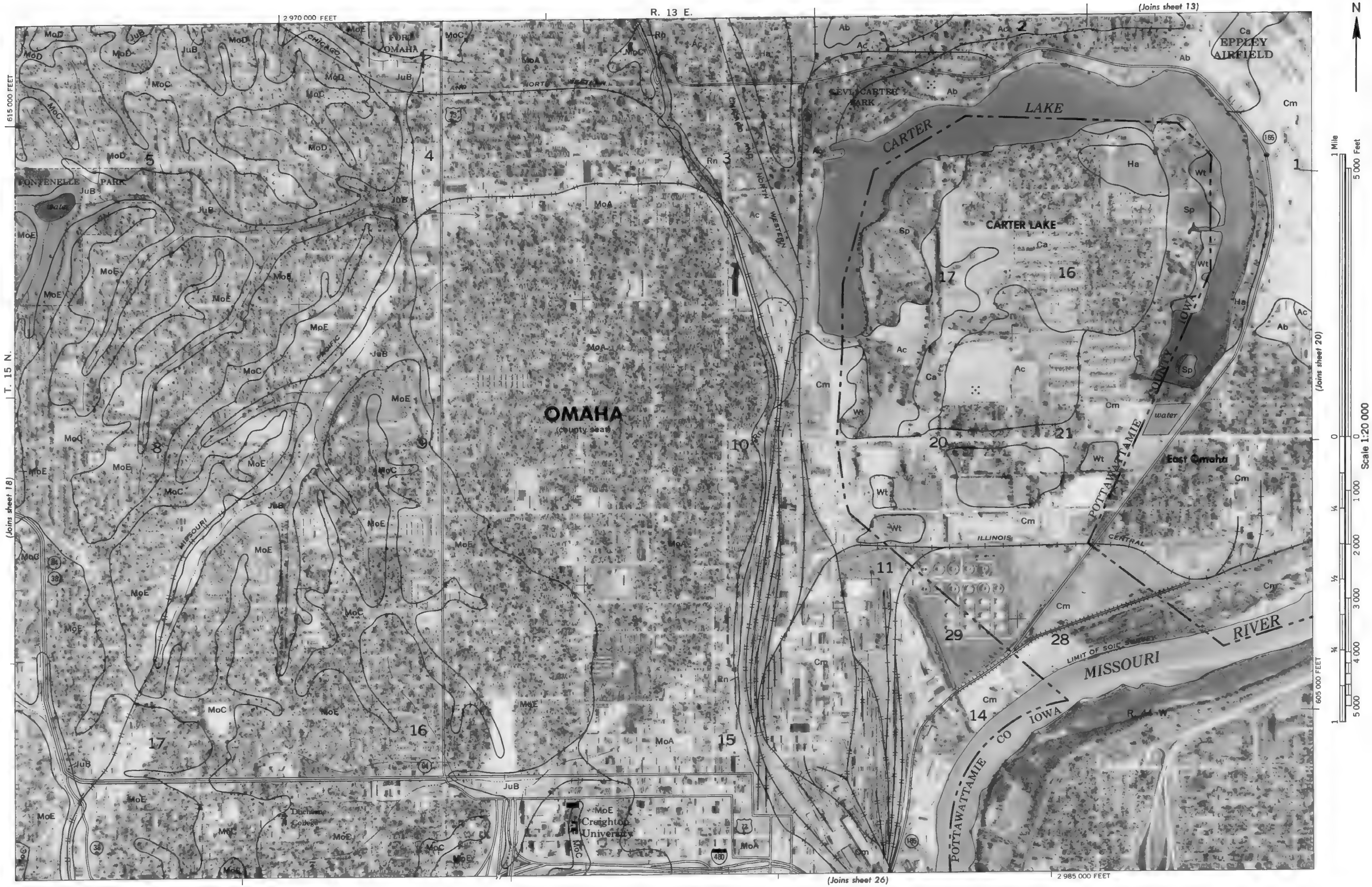




Land division corners are approximately positioned on this map.

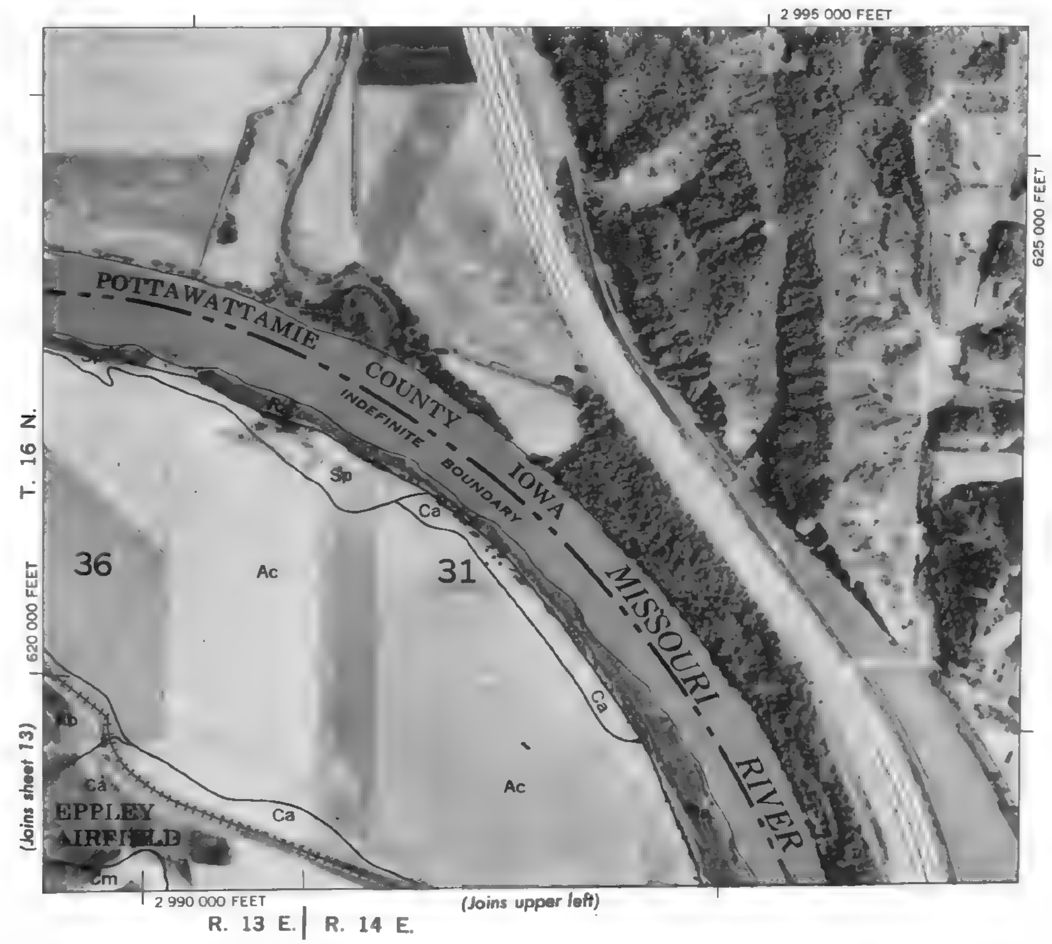
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.



DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 19

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 21

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map.

N

1 Mile

5 000 Feet

Scale 1:20 000

0 1 000 2 000 3 000 4 000 5 000

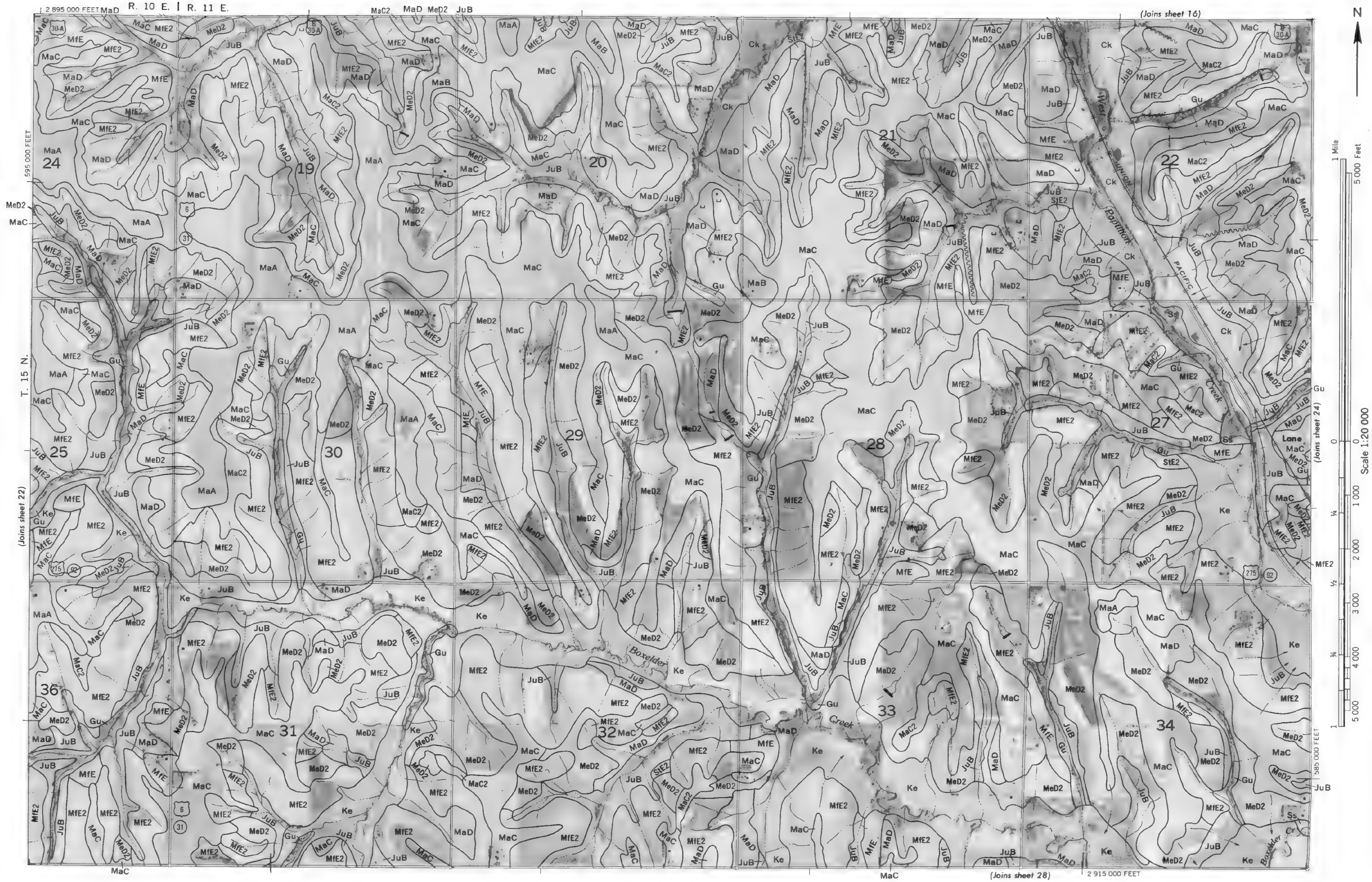
Land division corners are approximately positioned on this map.

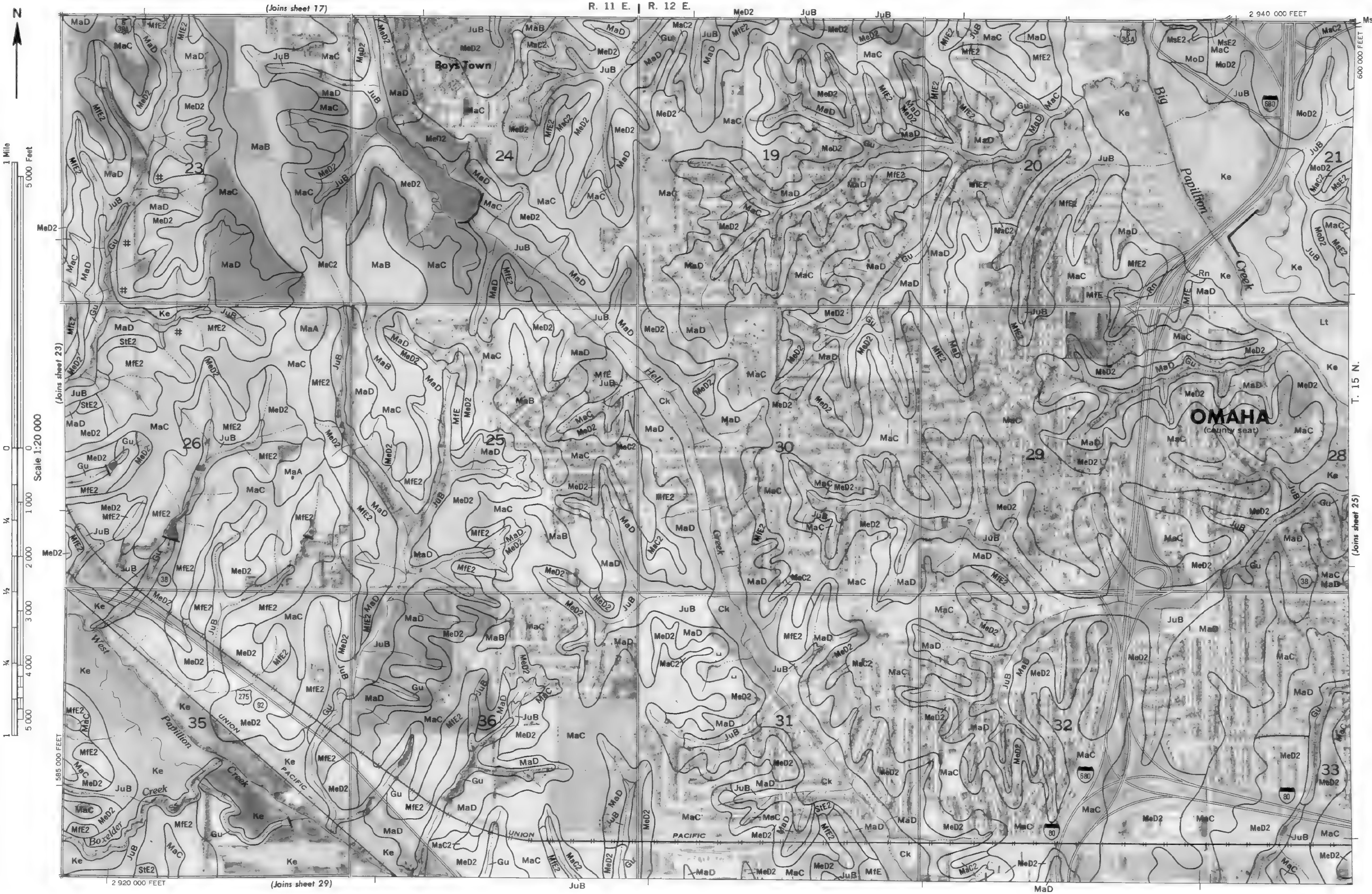
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 23

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map





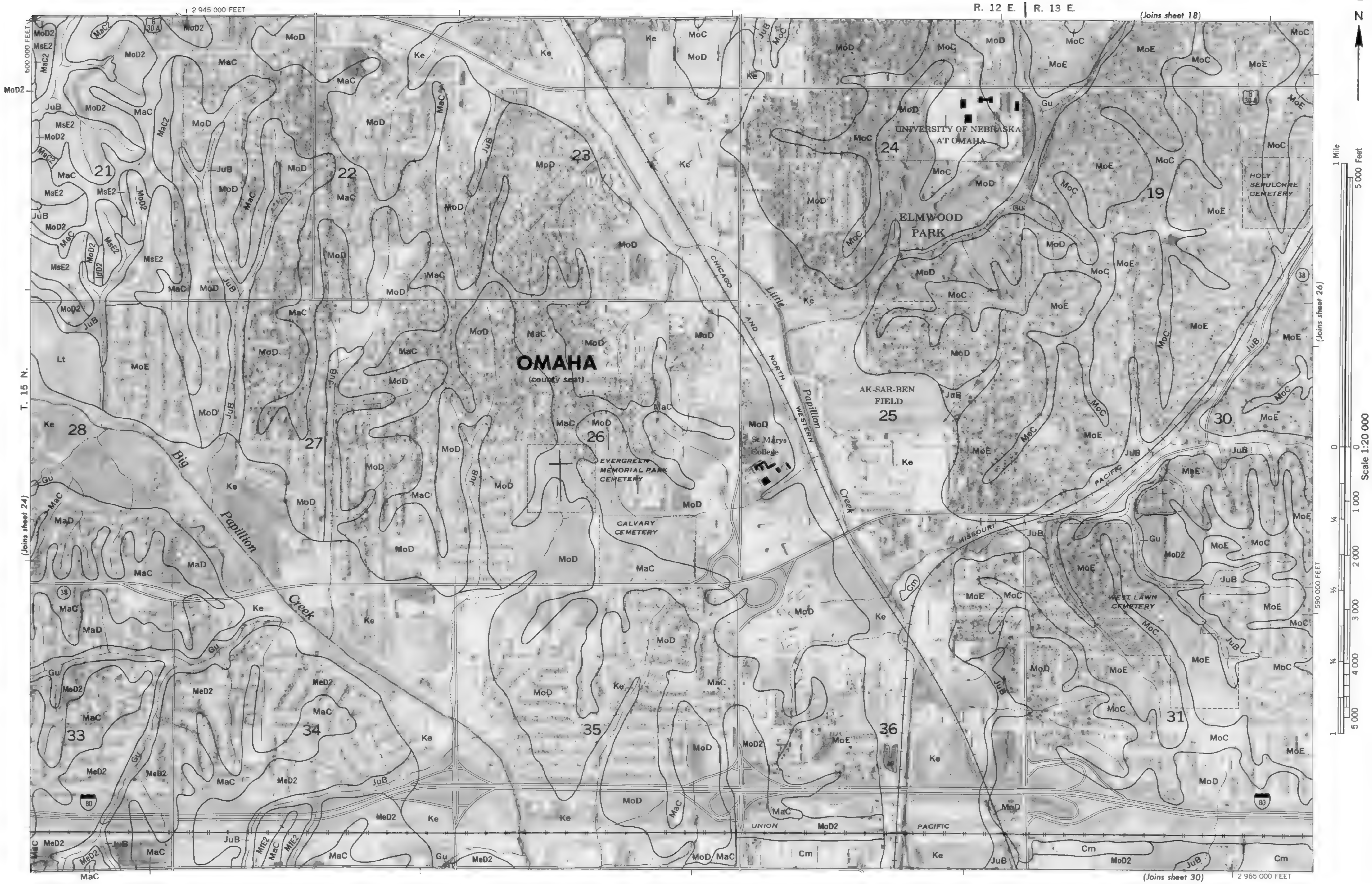
Land division corners are approximately positioned on this map.

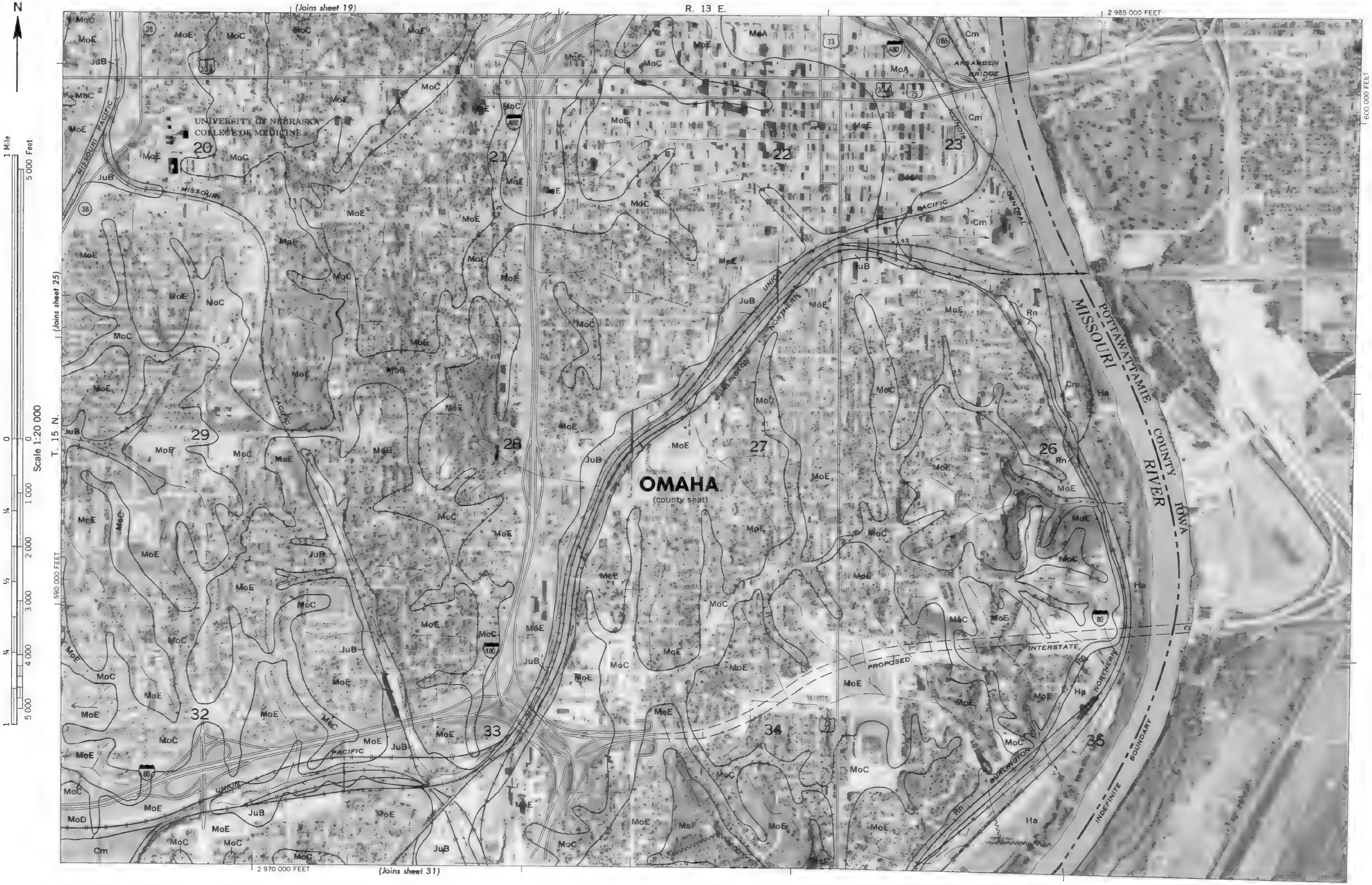
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 25

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division. Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone. Land division corners are approximately positioned on this map.

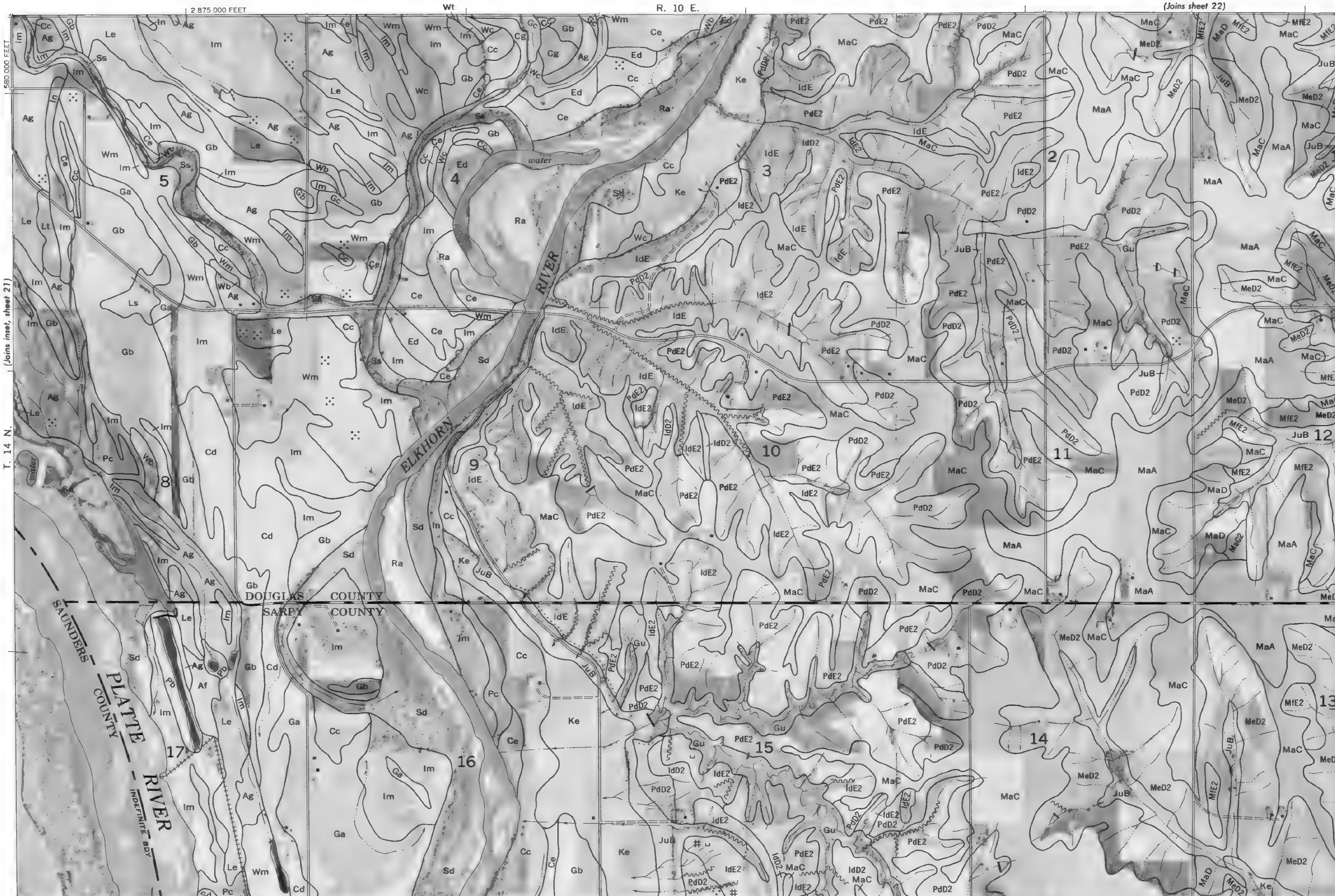




Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.



N

1 Mile

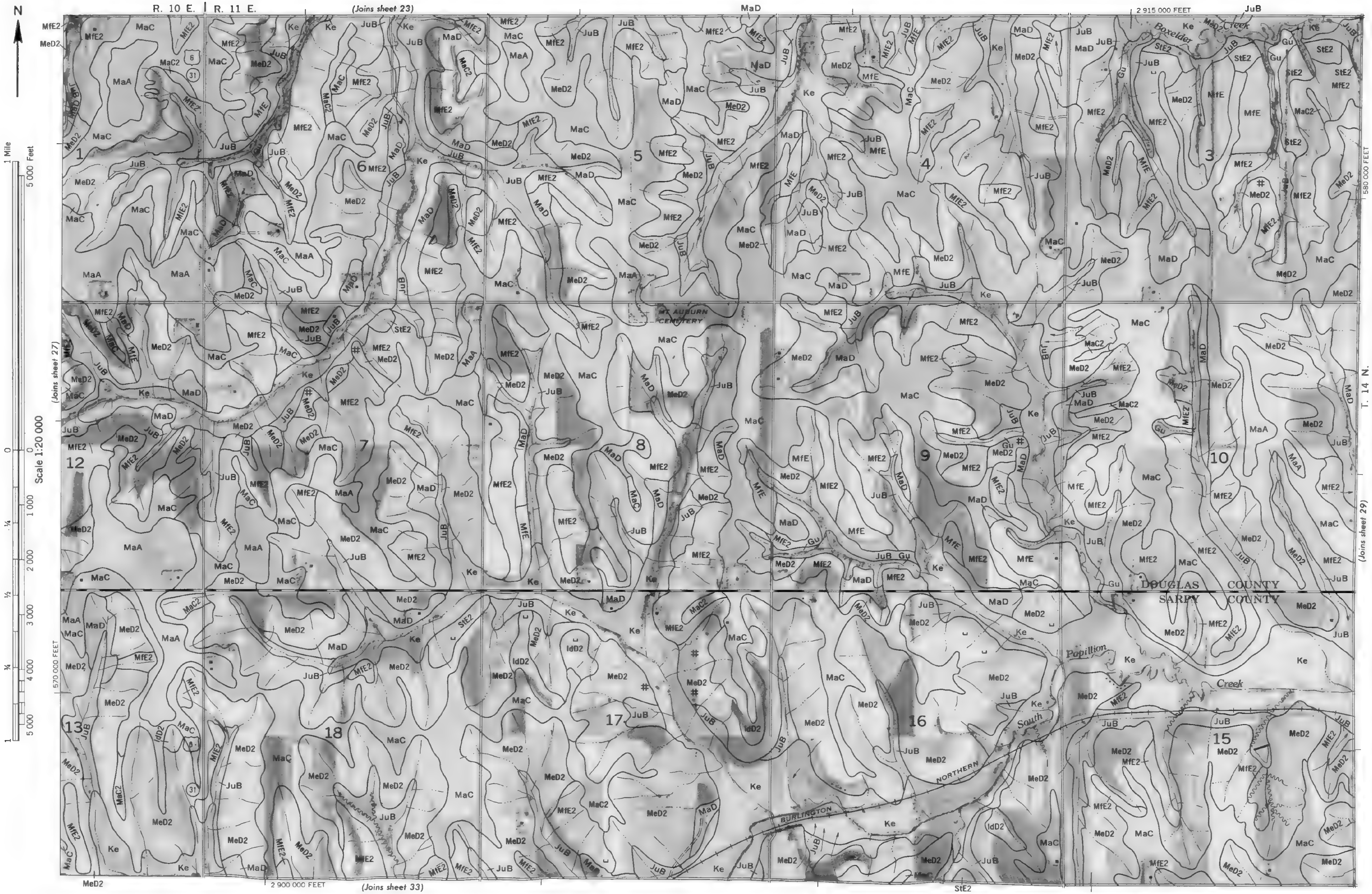
5 000 Feet

Scale 1:20 000

0 — 0
1 000
¼
2 000
½ — 3 000
¾ — 4 000
1 — 5 000

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 27

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map



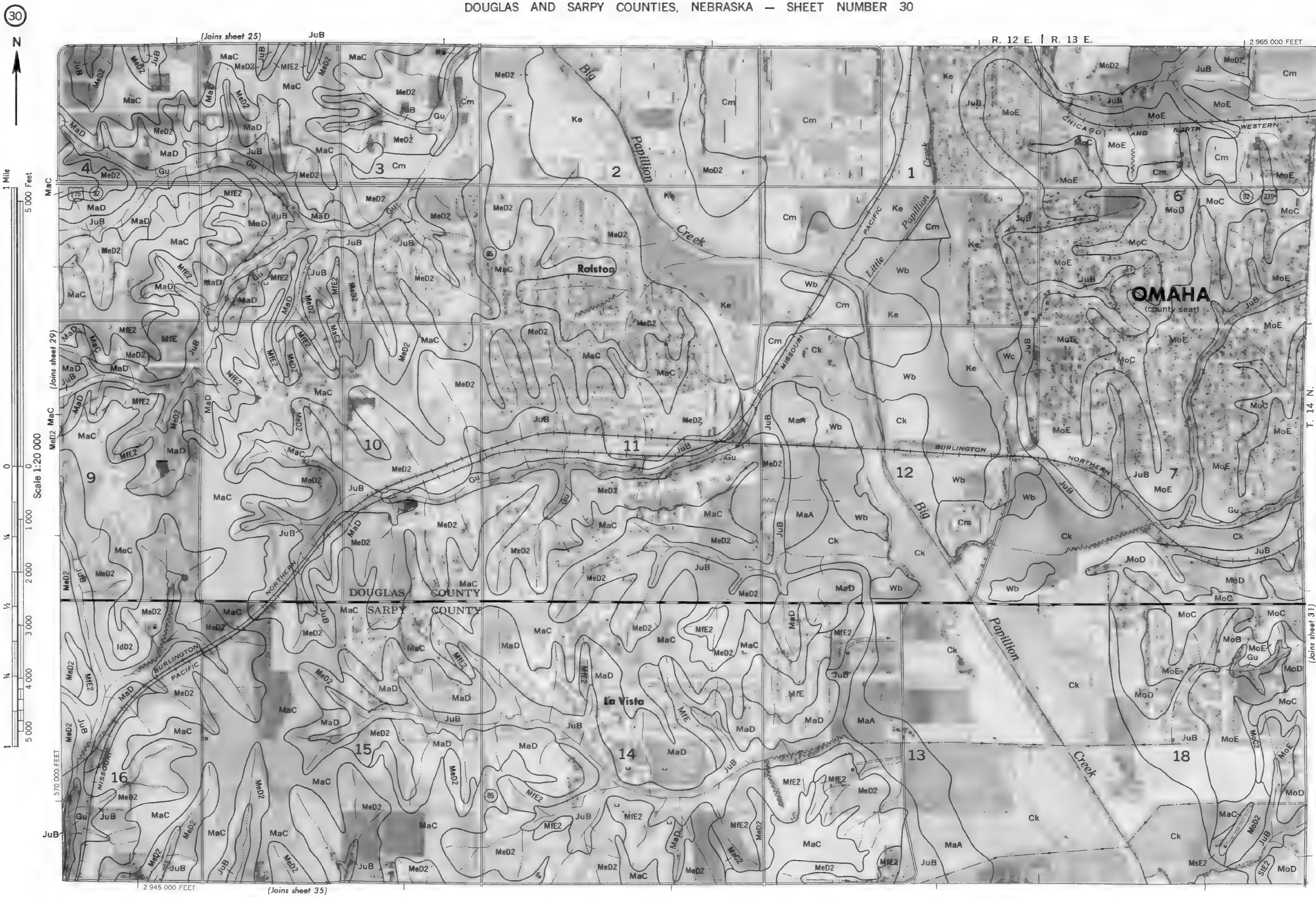
Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 29

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map



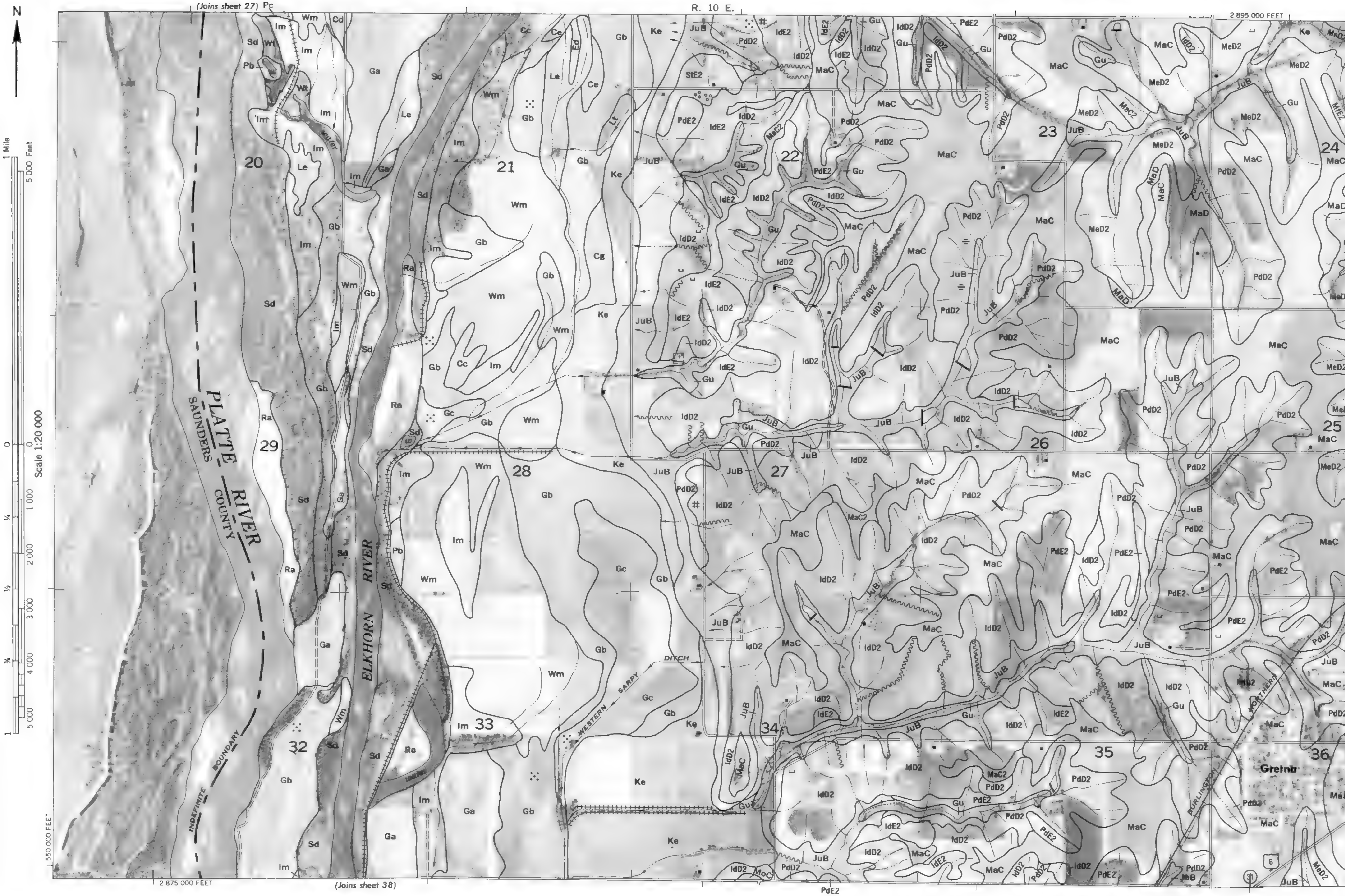
Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 31

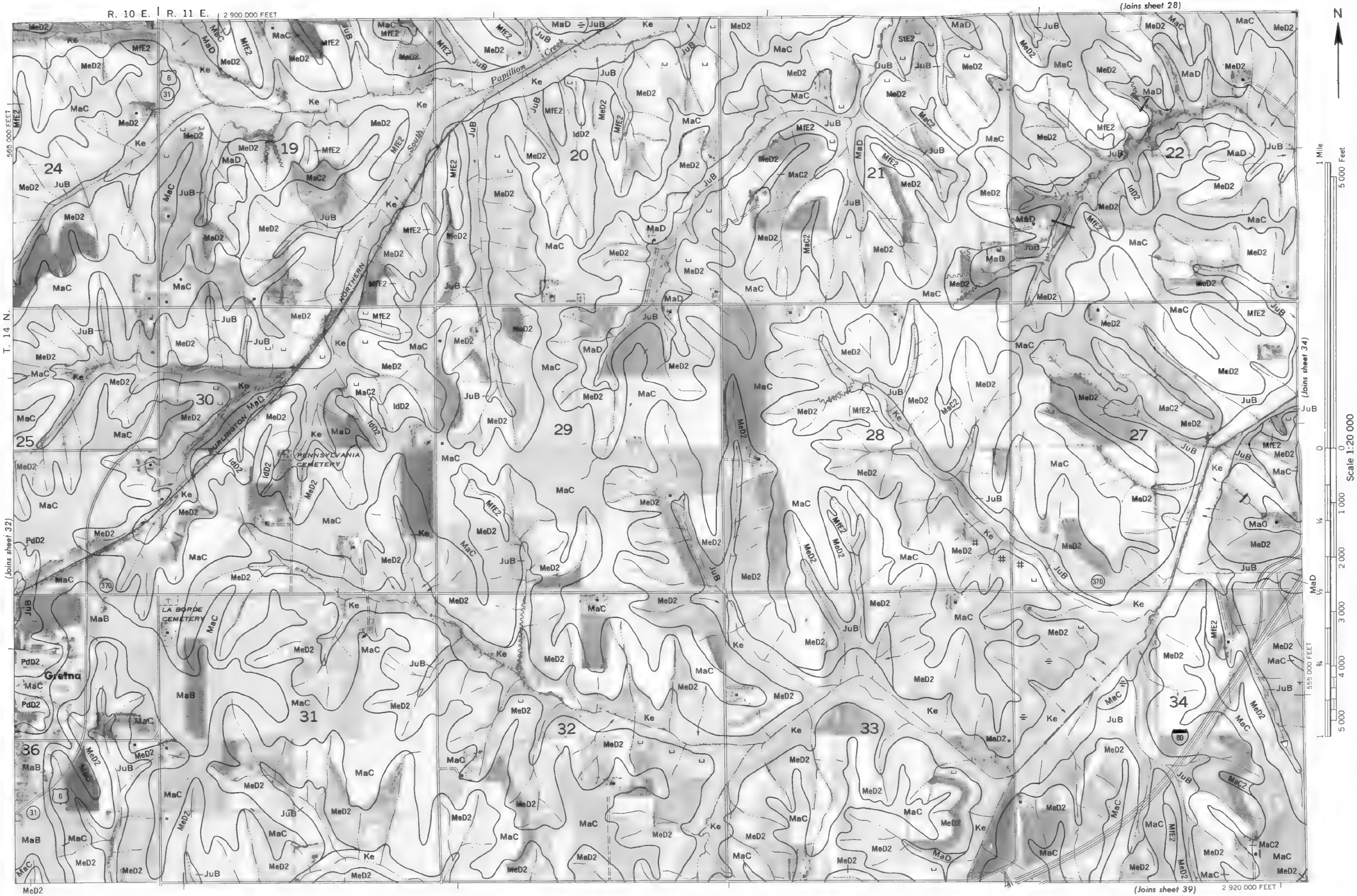
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map



Land division corners are approximately positioned on this map

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.



DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 33

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 34

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

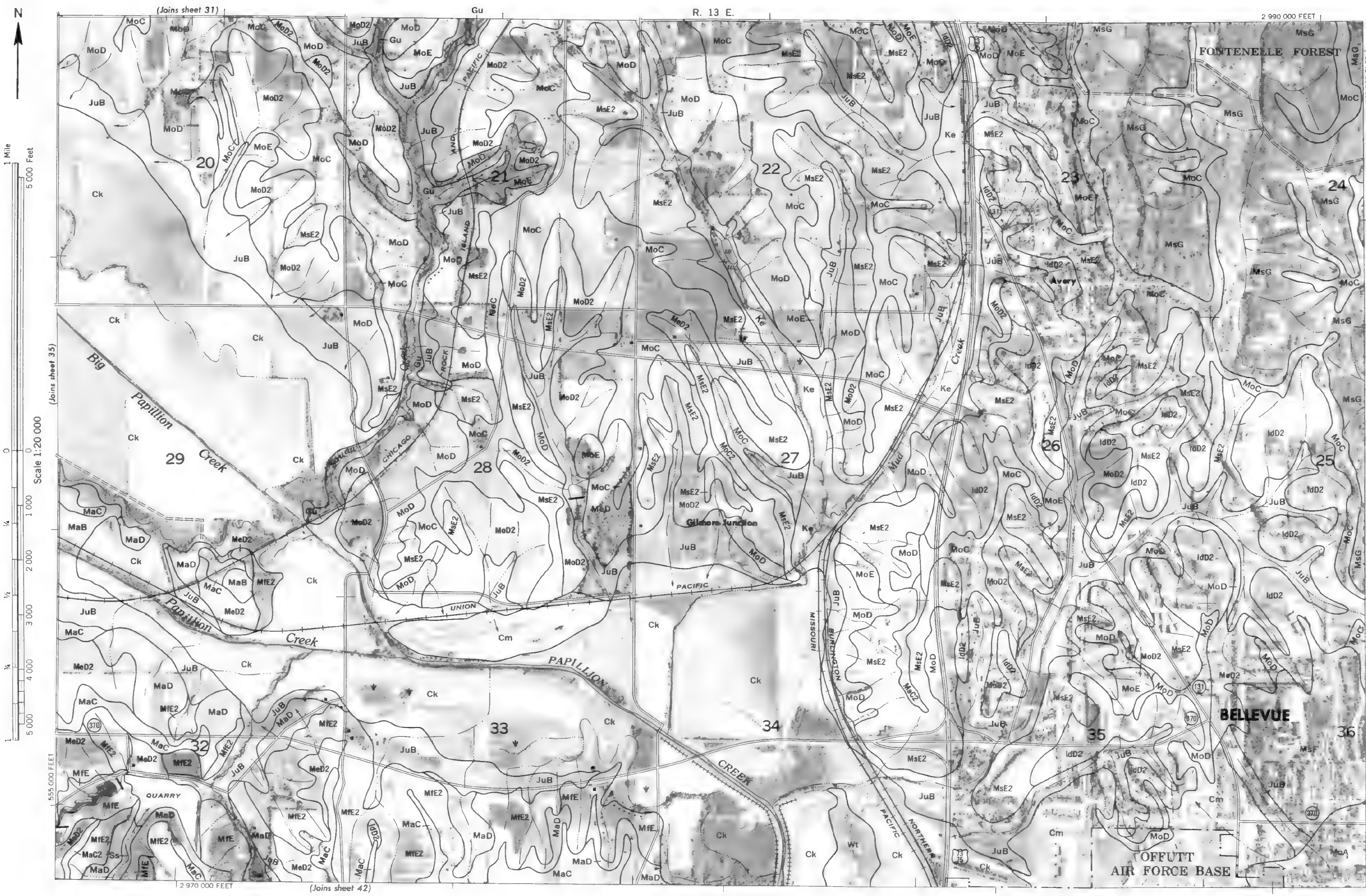
Land division corners are approximately positioned on this map.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 35

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

Land division corners are approximately positioned on this map



Land division corners are approximately positioned on this map

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 36

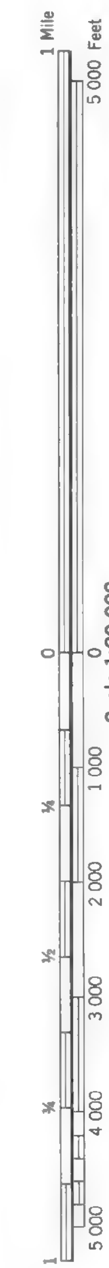
DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 37

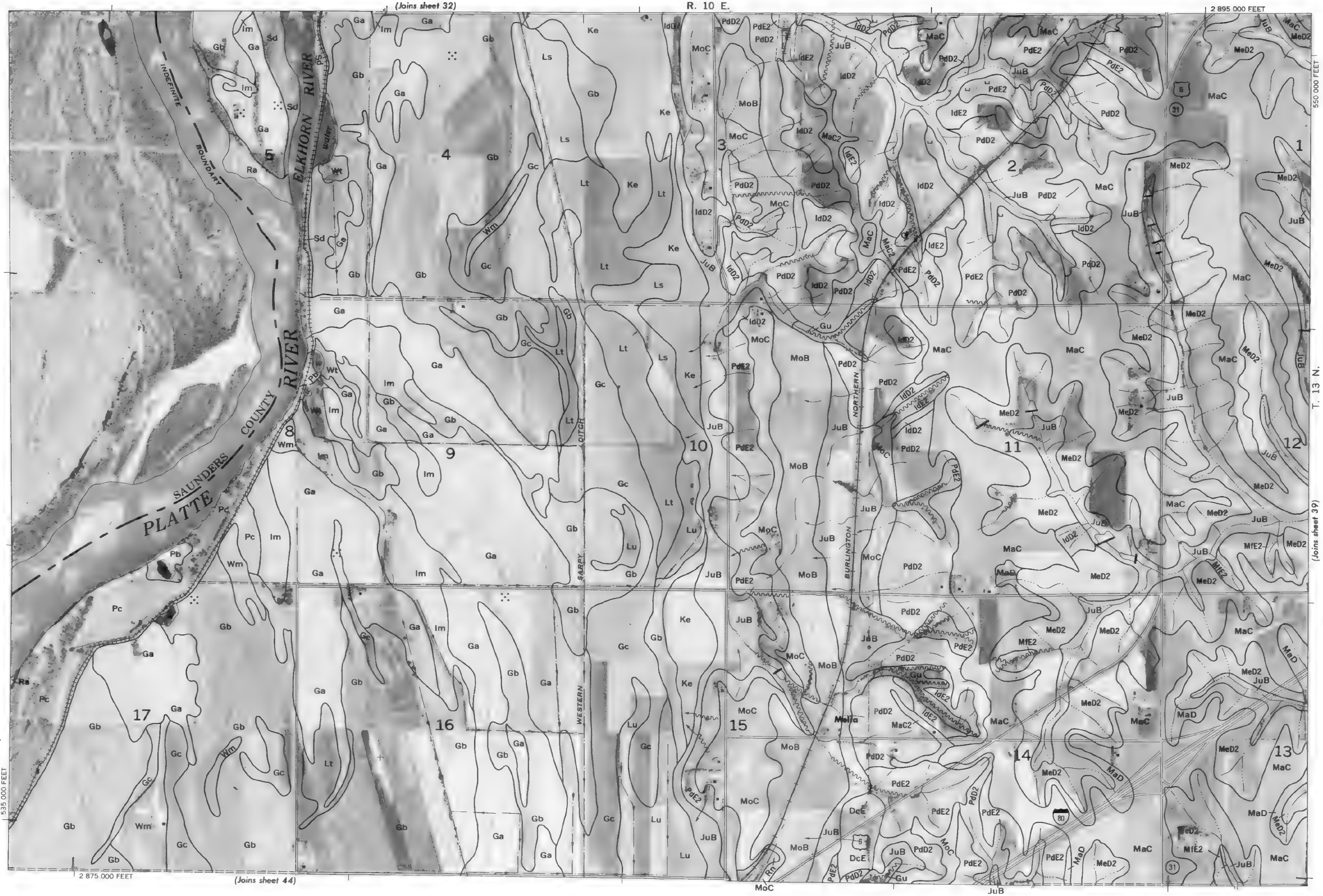
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the University of Nebraska, Conservation and Survey Division.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

Land division corners are approximately positioned on this map

4000 AND 5000 FOOT GRID TICKS





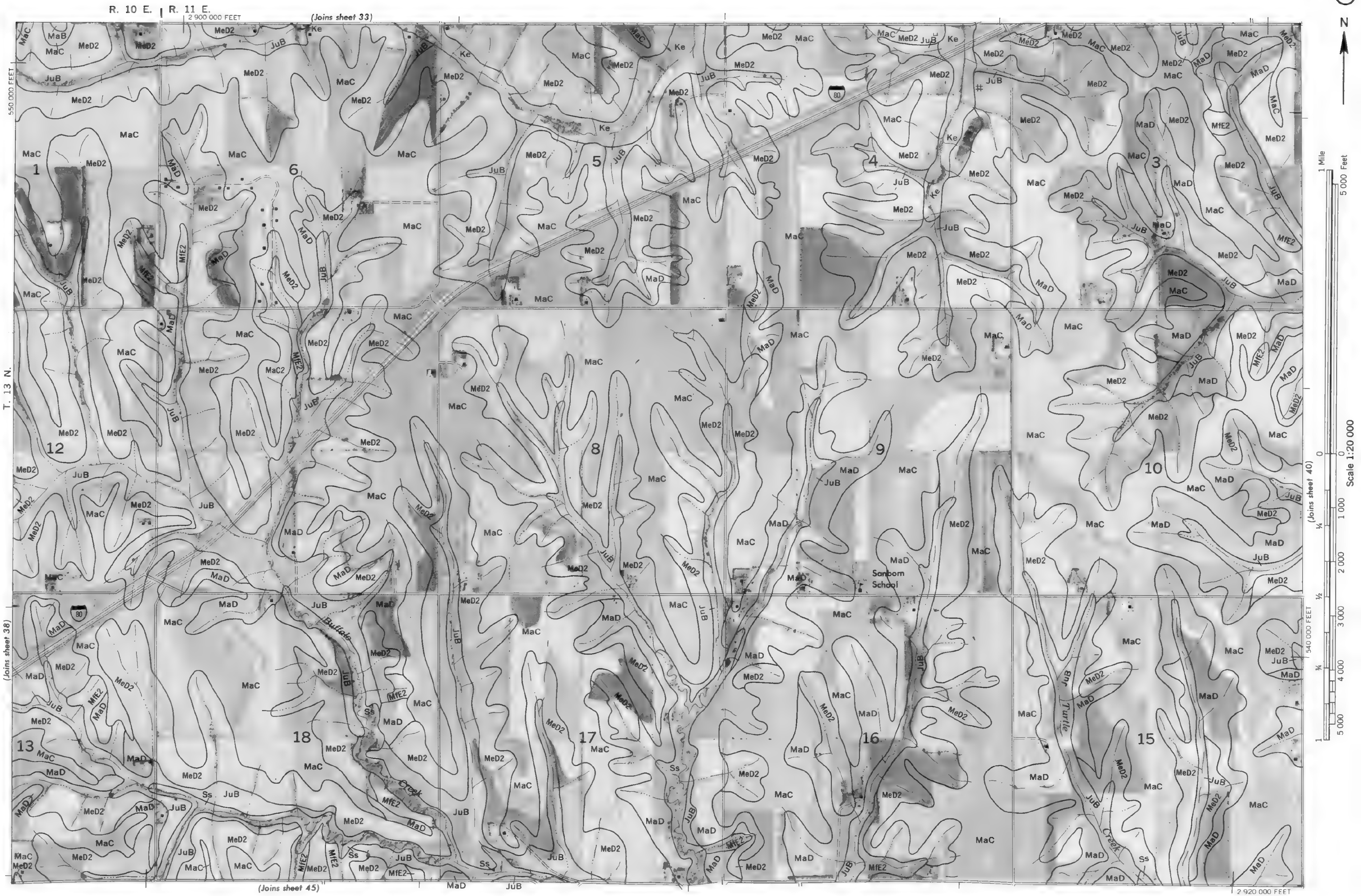
Land division corners are approximately positioned on this map

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

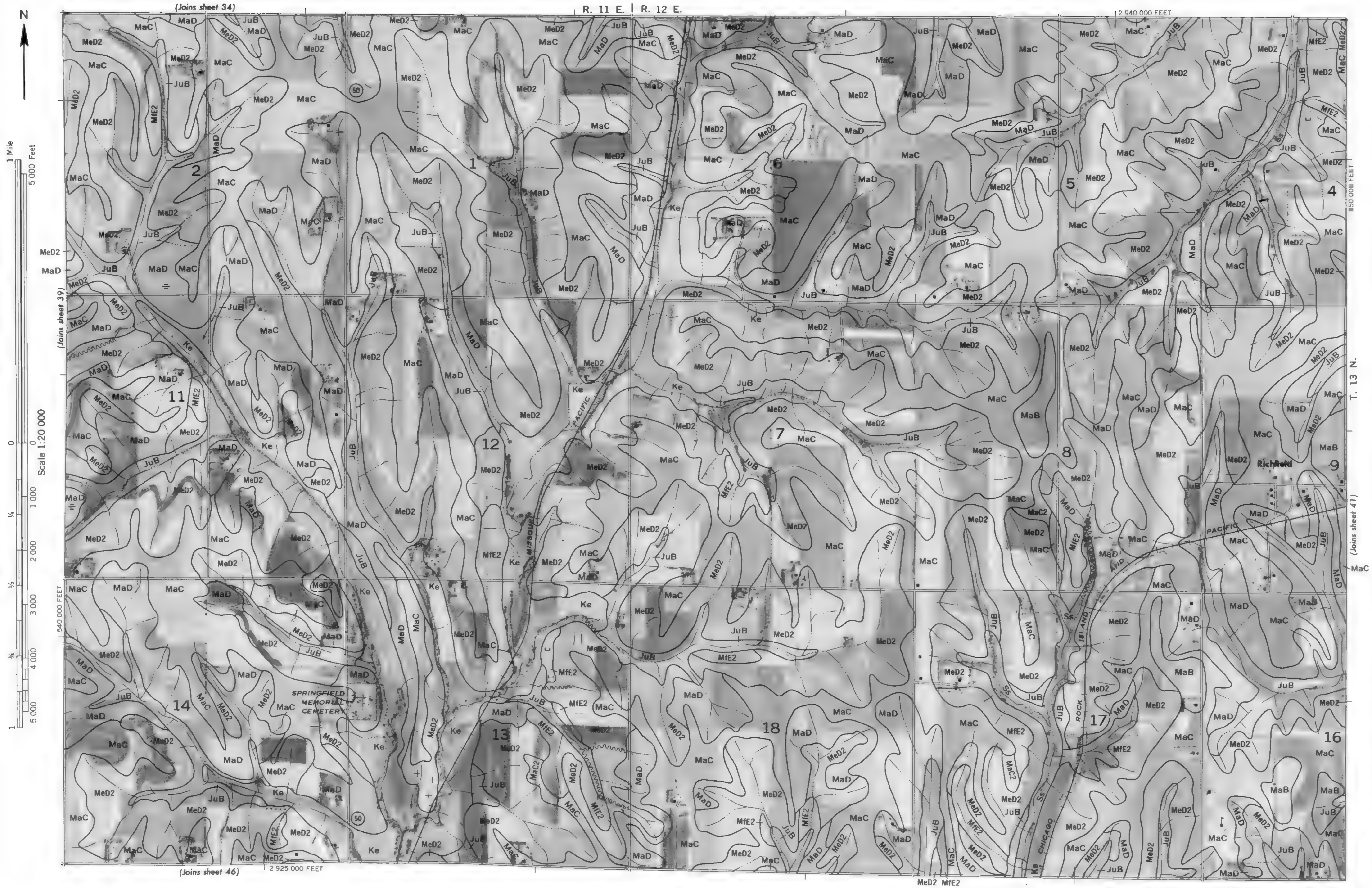
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 39

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map.



DOUGLAS AND SARPY COUNTIES, NEBRASKA — SHEET NUMBER 40



Land division corners are approximately positioned on this map.

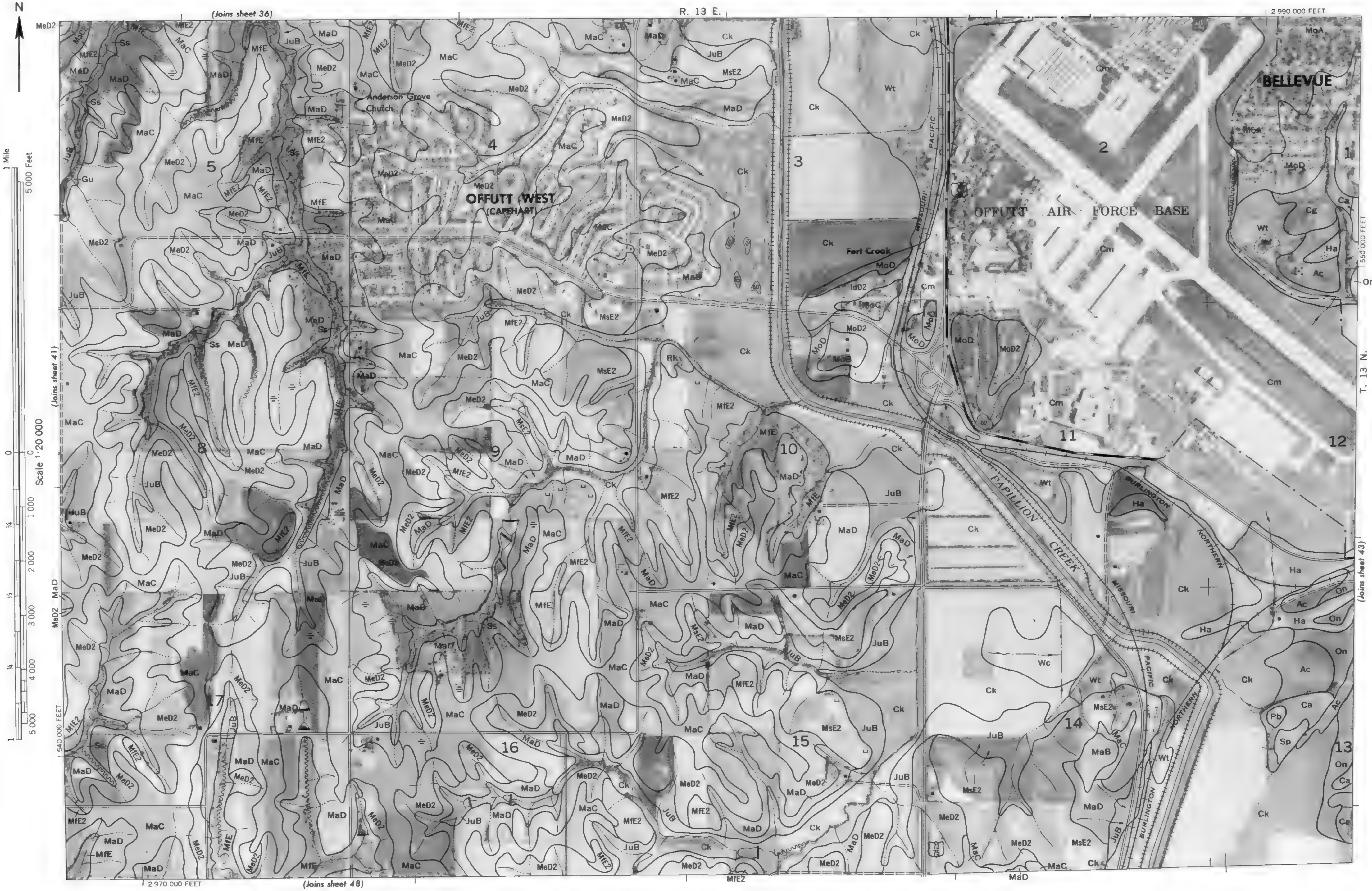
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 40

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 41

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map.



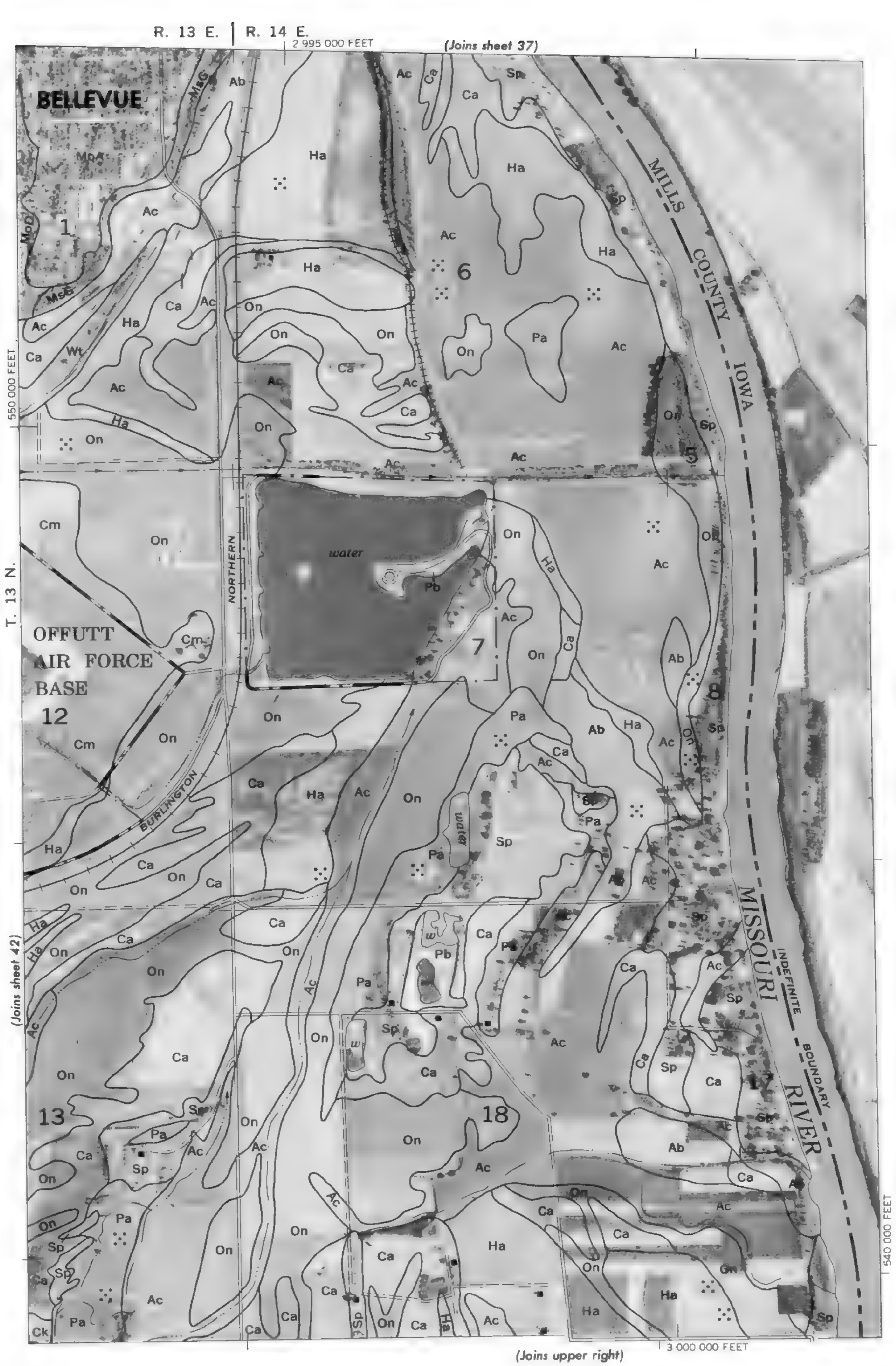
Land division corners are approximately positioned on this map

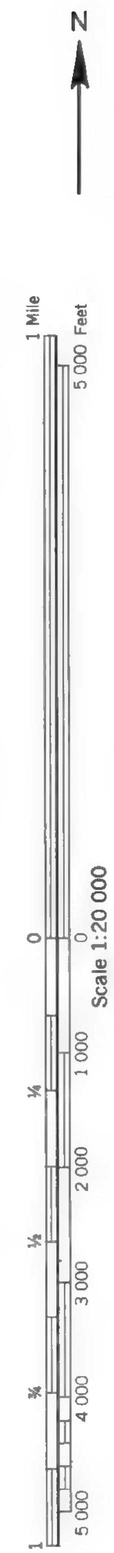
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

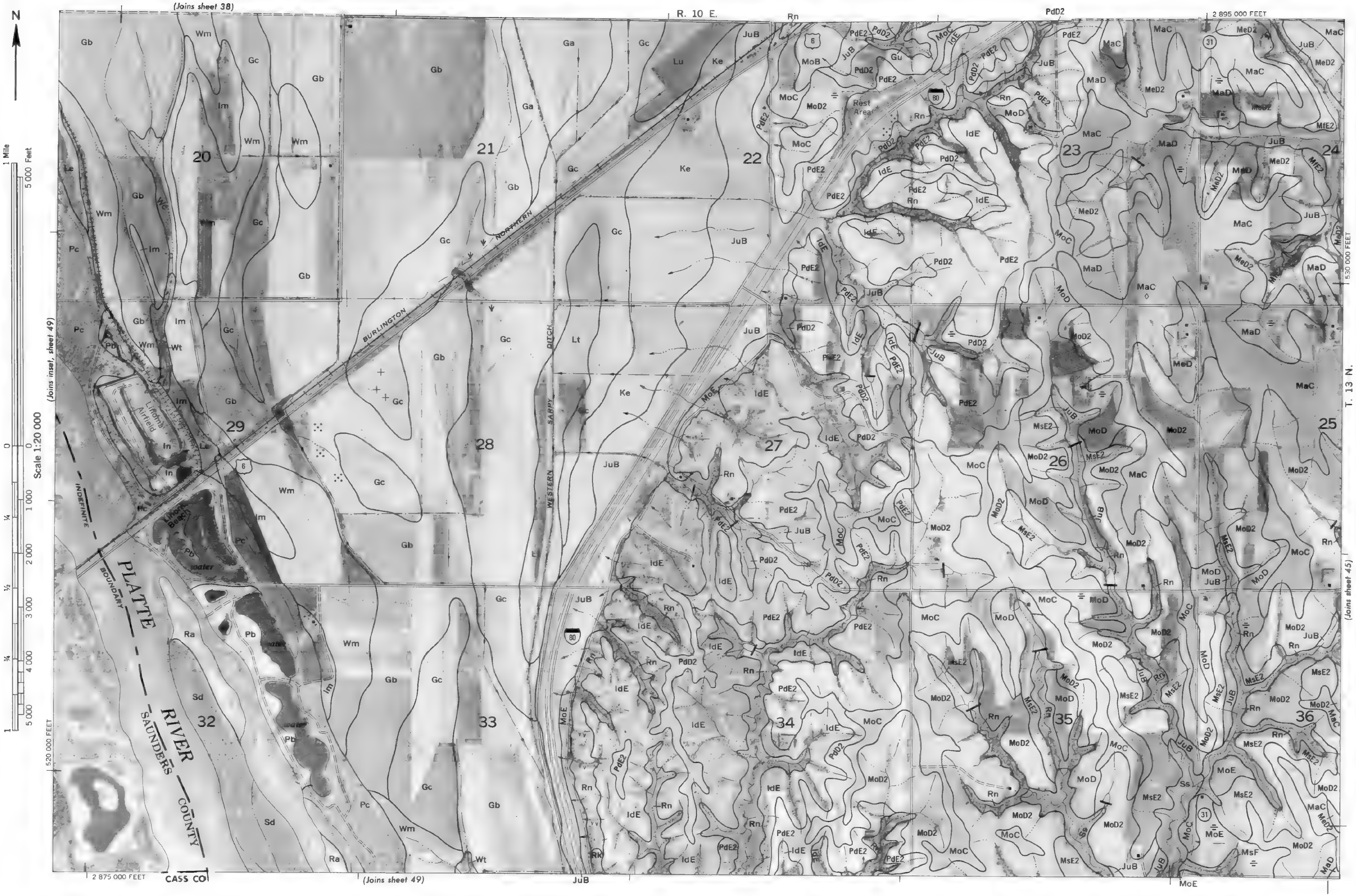
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 43

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map







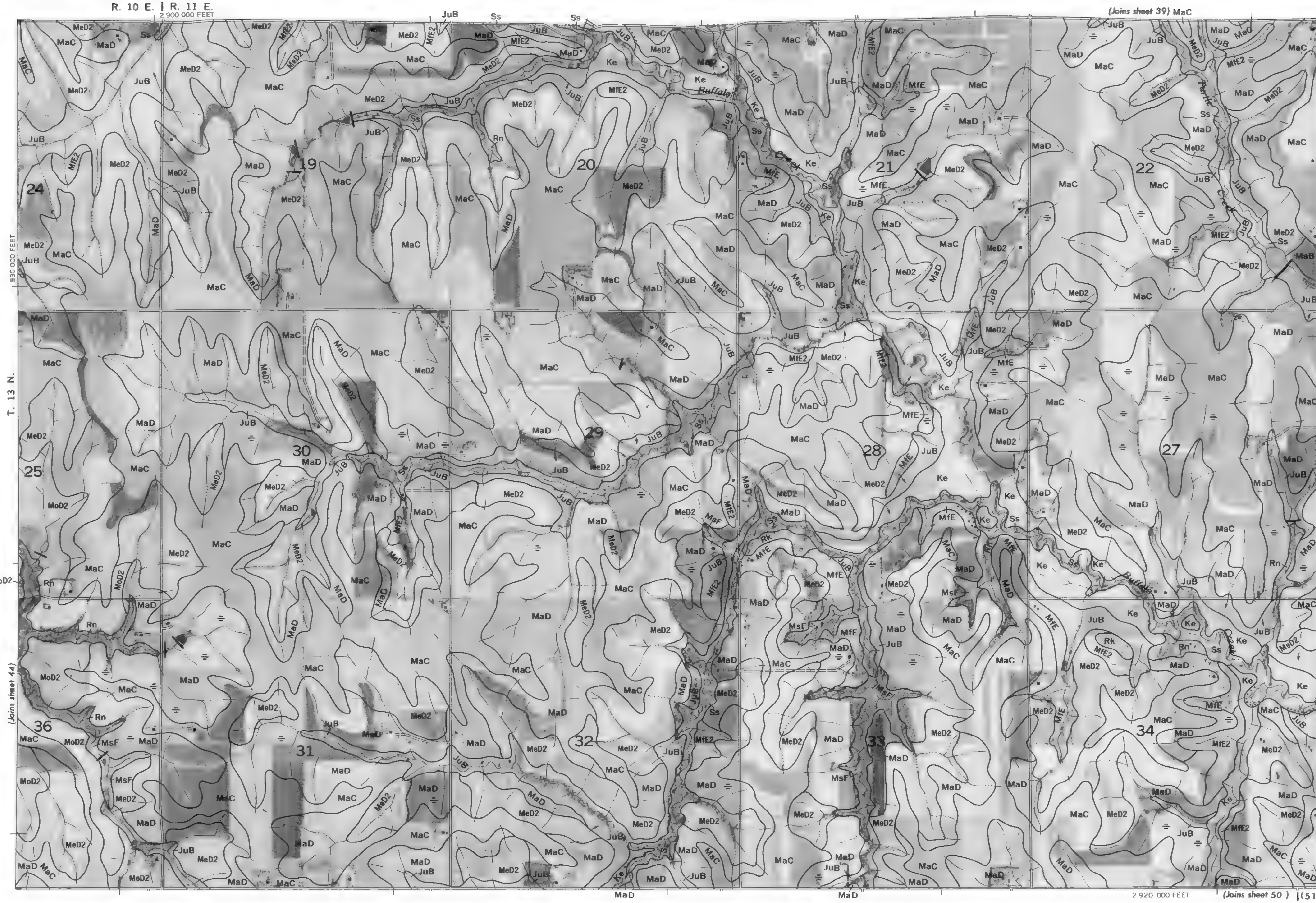
Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 44

45



DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 45

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map

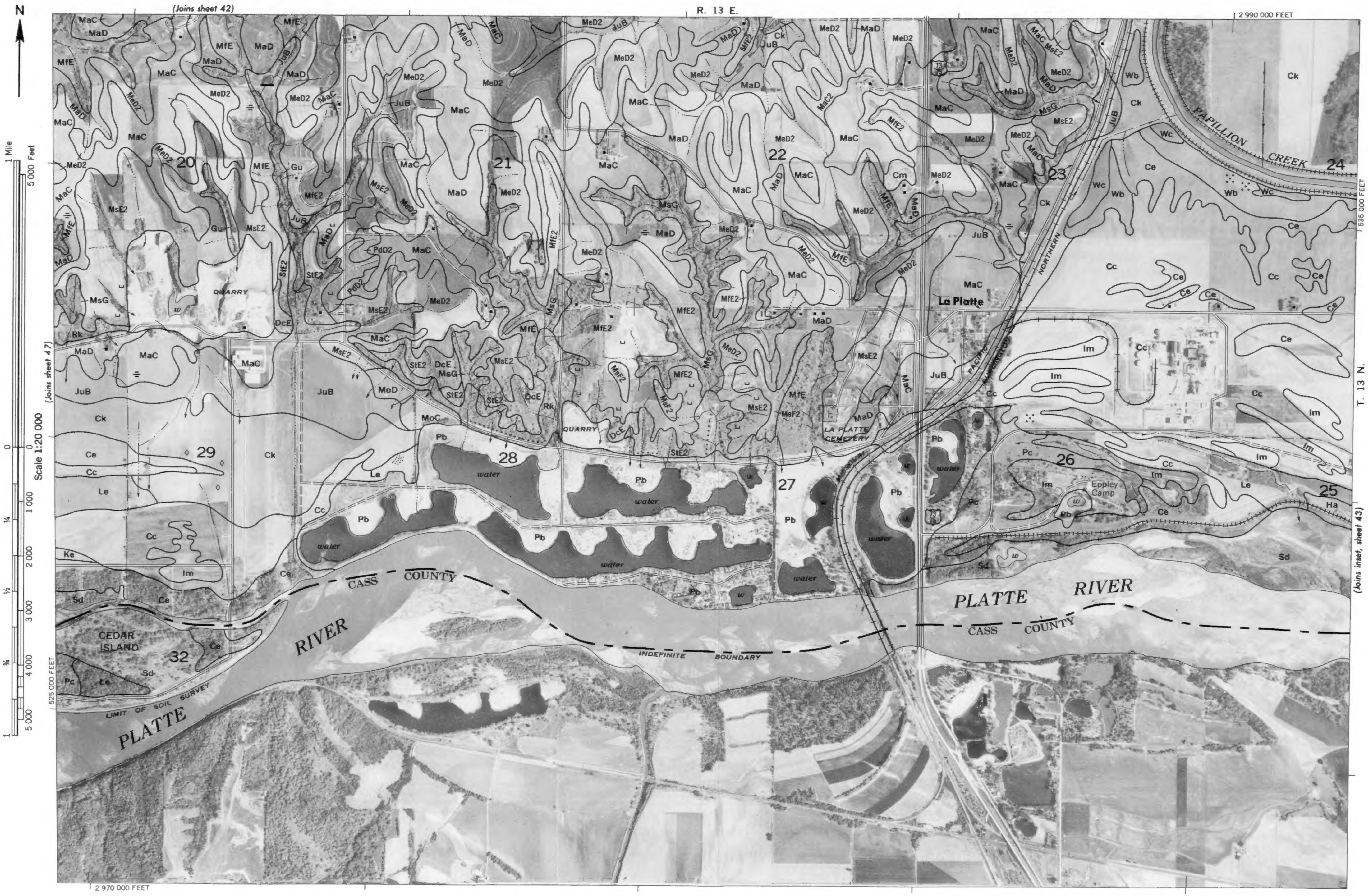
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 46

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 47

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map.

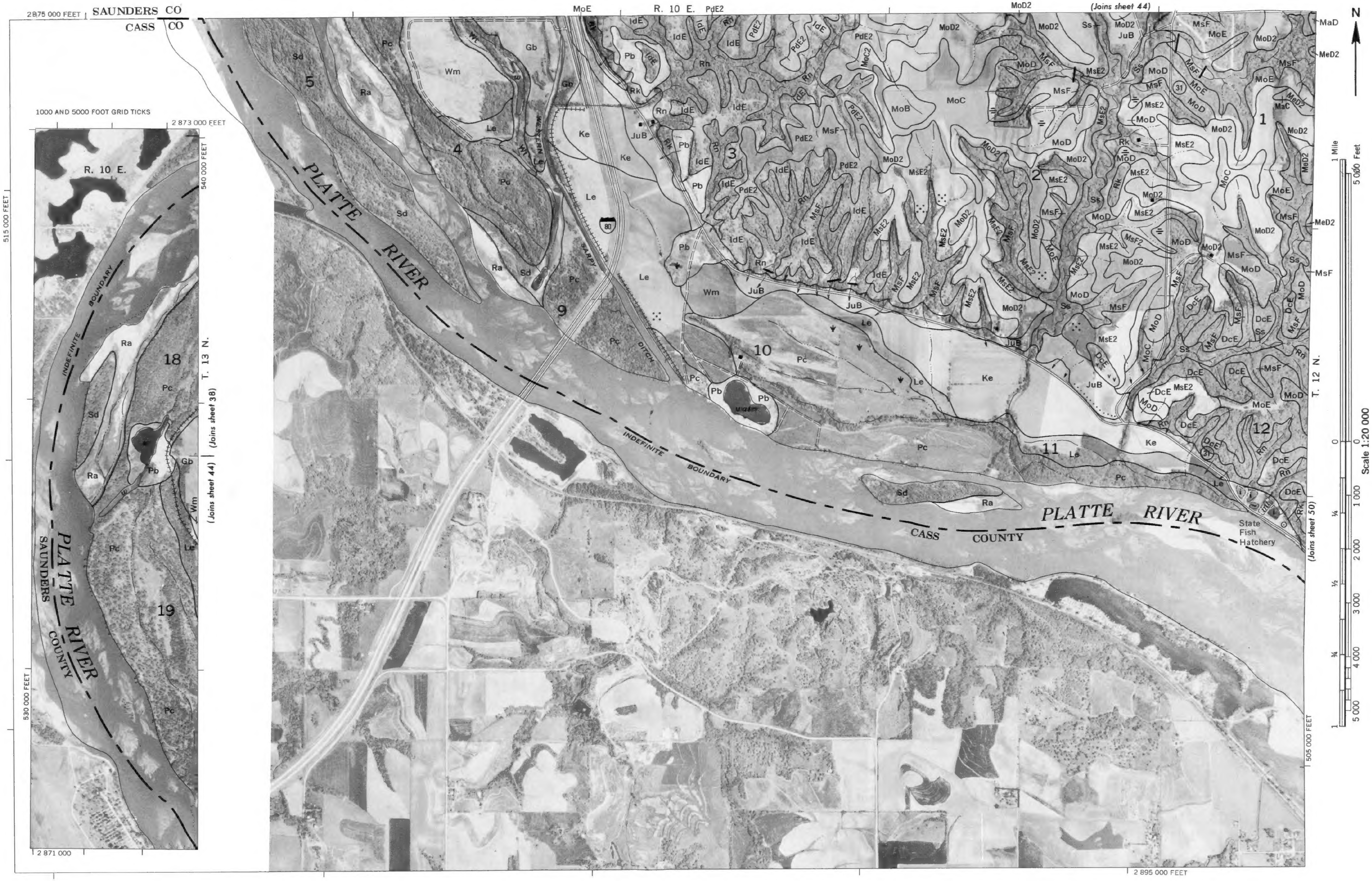
DOUGLAS AND SARPY COUNTIES, NEBRASKA — SHEET NUMBER 48



Land division corners are approximately positioned on this map.

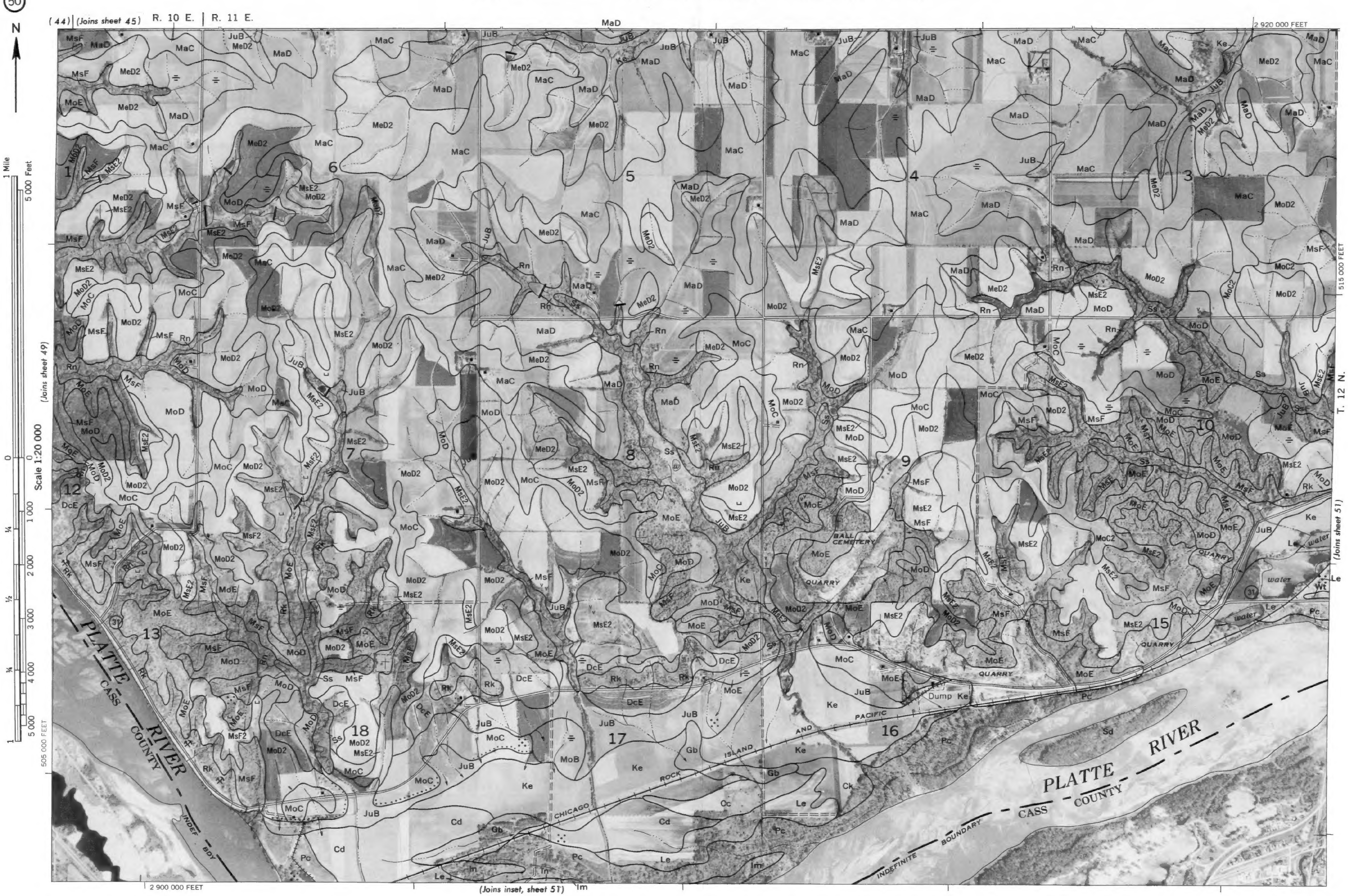
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.



DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 49

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map.



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of Nebraska, Conservation and Survey Division.

DOUGLAS AND SARPY COUNTIES, NEBRASKA NO. 50

DOUGLAS AND SARPY COUNTIES, NEBRASKA- NO. 51

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the University of Nebraska, Conservation and Survey Division.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Nebraska coordinate system, south zone.
Land division corners are approximately positioned on this map.